GOVERNMENT OF INDIA

PLANNING & DEVELOPMENT DEPARTMENT

OFFICE OF THE INDUSTRIAL ADVISER

# REPORT

OF THE

# INDUSTRIAL PANEL

ON

# NON-FERROUS METAL INDUSTRIES

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# INTRODUCTION

The Non-Ferrous Metal Industries Panel was constituted by the Planning and Development Department of the Government of India to make recommendations to the Government regarding the postwar development of both existing and new Non-Ferrous Metal Industries in India. The General Directive to Industrial Panels (Appendix I) constitutes the terms of reference of the Panel and is very wide in its scope.

Initially we had considerable trouble in carrying out the work of the Panel since no Secretary or clerical staff had been appointed. Our thanks are due to the Indian Aluminium Company Limited, Calcutta for loaning, partime, the services of their Metallurgist Mr. D.P. Antia from June 1st, 1945, to act as Honorary Secretary to the Panel. Our thanks are also due to Mr. M. S. Krishnamurti and Mr. G. Anant Ram for doing the secretarial work.

The work of the Panel was carried on from the Offices of the Directorate General of Munitions Production, 6, Esplanade East, Calcutta. Altogether five meetings of the Panel were held, one at Calcutta, two at New Delhi* and two at Bombay. Besides this, a joint meeting with the Electro Chemical Industries Panel was held at New Delhi. The Panel visited the Katni and Ambernath Ordnance Factories, and the factories of the Star Metal Refinery, Bombay and Kamani Metal Industries, Bombay and Jaipur. The Secretary also visited several factories both at Calcutta and Bombay and we thank the Metals Directorate of the D.G.M.P., Calcutta and the Director of Munitions Production, Bombay for arranging these visits.

For collecting relevant information questionnaires (Appendix II) were sent to industrial firms, Chambers of Commerce and provincial and State Governments. Deputations from All India Manufacturers' Organisation and Indian Non-Ferrous Metals Manufacturers' Association were also received by the Panel. Besides, members of individual firms were interviewed. The Metals Directorate of the D.G.M.P. also helped considerably in collecting information.

Mr. G.C. Mitter of H.M's Mint, Bombay and Mr. J.G. Berry, Director of Metals (Non-Ferrous) were co-opted as members during the first meeting.

On the mineral side of our work we received considerable help from Mr. D.N. Wadia, Mineral Adviser to the Government of India. Our thanks are also due to the Geological Survey of India and Mr. B. Rama Rao, Director, Mysore State Geological Survey. We also thank the Metals

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* **Including one with Provincial and State Representatives.**

Committee of the Board of Scientific and Industrial Research for permitting us to include their notes on 'Possibilities of a Light Metal Industry in India' as an appendix to this report. These notes have been slightly modified to suit our requirements.

The Planning and Development Department was unable to give us any provisional production targets to be aimed at during the first five postwar years. We therefore had to set our own targets after considering the requirements of the various industries. We regret to say that in spite of all our efforts the nature of information available to us from industrial firms, without few exceptions, was not satisfactory. This may be due to the firms not being certain about their postwar developments due to the present unstable market conditions. Altogether over fifty firms were approached for information. Twentyone firms replied and their relevant answers are summarised in Appendix III. The recommendations made in this report are on an all Indian basis and wherever the word 'India' is used it includes both British India and Indian States. Indian States should be represented on all Committees, deputations etc. organised by the Central Government.

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## CHAPTER I

## A BRIEF SURVEY OF PRESENT POSITION OF MINERAL AND METAL INDUSTRIES OF INDIA

### Mineral Position of India

There is no justification for the widely prevailing opinion that India is poor in her mineral resources for developing large-scale non-ferrous metal industries. It is the usual practice in India to dismiss without detailed prospecting non-ferrous ore deposits which occur in a scattered or disseminated state as not worth the attention of modern metal miner or smelter. This practice has worked to the detriment of the industry since an ore deposit having once been rejected as too small or uneconomic to work has never again been touched for further prospecting in spite of wide-spread evidence in the form of slags and mine dumps indicating the deposit having been worked by the ancients. The attention of the Geological survey of India has hitherto been confined to the more immediately paying and larger metalliferous deposits, the less extensive deposits receiving hardly any attention. A systematic prospecting for metallic ores has never been attempted in India and hence the information available to the Panel has been sketchy and incomplete.

The relative position of India with regard to supply of industrial minerals has been given by Mr. D. N. Wadia* the Mineral Adviser to the Government of India, as follows :—

"1. Minerals of which our exportable supplies can dominate the world market :—

Iron ore, Titanium ore, Mica.

"2. Minerals of which our exportable surplus forms an important factor :—

Manganese ore
Bauxite
Magnesite
Refractory minerals
Natural abrasives
Steatite
Silica
Gypsum
Monumental granites
Monazite
Beryllium
Corundum

"3. Minerals in which India may be considered self-sufficient for present needs and those of the immediate future :—

Coal
Cement materials
Aluminium ore
Gold
Copper ore
Chrome ore
Building stones
Marble
Slate
Industrial clays
Limestone and Dolomite
Mineral Pigments
Sodium Salt and Alkalies
Alum
Glass sand
Pyrite
Borax
Felspars
Nitrates
Phosphates
Zircon
Arsenic
Antimony
Barytes
Precious and semi-precious stones
Vanadium
Rare earths.

"4. Minerals for which India has to depend largely or entirely on foreign imports :—

Silver
Nickel
Mercury
Tungsten

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* The Mineral outlook in India by Mr. D. N. Wadia, Science and Culture, Vol. VII p. 515-518, 1941-42.

Petroleum
Sulphur
Lead
Zinc
Tin
Molybdenum
Platinum
Graphite
Asphalt
Potash
Fluorides. "

The approximate value of ores, minerals and metals which India has been producing of late ranges from 30 to 35 crores of rupees per year. An analysis of the figure for the year 1937-38 shows that to the annual estimated aggregate value of our mineral industries, metals, ferrous and non-ferrous, contributed 13 to 14 crores of rupee (about 40 to 43 per cent. of the total). Of this the industrial non-ferrous metals produced in India contributed a mere half a crore of ruppees. Mineral fuels consisting of coal and petroleum contributed 9 to 12 crores (about 20 to 25 per cent); industrial minerals including mica, manganese ores, chromite, magnesite and several others about 8 to 8·5 crores (about 20 per cent); and building materials like stones, clays, sand, cement, etc., about a crore (3 to 3·5 per cent.)

Comparing these figures with those of the United Kingdom, Canada, and other Industrially advanced countries, we find that India's production is the lowest. For instance, in 1935 the estimated value of metals, minerals and mineral fuels produced in the United Kingdom was approximately 220·87 crores of rupees; in the Union of South Africa 112·10 crores in Canada 84·59 crores; in Australia 28·01 crores and in India (inculding Burma) 26·01 crores. Subsequent to 1935 India's position has slightly improved—the value of her annual production increasing by some 8 to 10 crores of rupees. But this increase bears no comparison with the improvement which Canada and other countries have shown during the same period. Canada has made vast strides in developing her mineral industries—her production increasing to 132·6 crores of rupees in 1938, to 141·0 crores in 1939 and to 169·2 crores in 1942. In other words, while Canada has doubled her production—from 84 to 169 crores—between 1935 and 1942, India's increase for the same period—from 26 to 35 crores— hardly exceeds by two-fifths. Similar progress could be noticed in the case of the Union of South Africa and Australia.

Considering the extent of the country and its total population, the progress of India's mineral and metal industries—during the last 50 years—though not quite negligible cannot be regarded as speedy or extensive. Among the causes of this tardy growth may be mentioned the following :—

1. Lack of policy and organised plans for prospecting, mining and utilization of minerals.

2. Lack of effective State control, assistance and encouragement.
3. Absence of basic industries.
4. Lack of trained men and technical skill.
5. Want of reliable information on the industrial application of minerals.
6. The haphazard mining of the ore bodies with an eye for immediate gains leading to the rapid depletion and waste of the useful portions of the deposits.
7. Inroads of foreign firms who have taken up concessions for most of the important Indian minerals.

In India, mining and prospecting have been left entirely to private enterprise and Indian industrialists and entrepreneurs generally fight shy of investing their funds in large-scale mining and metallurgical industries where they have to compete against foreign interests. Those who do venture concentrate their attention on raising only such of the minerals and ores-like mica, manganese ore, chromite, etc., as could be rapidly exported or sold without elaborate processing or metallurgical treatment.

That the people of India never lacked enterprise in venturing into mining and metallurgical fields is amply manifested in the old workings for gold, copper, lead, zinc and other metalliferous ores scattered about in different parts of India. The skill which the people of this country had attained in the metallurgy of iron and steel and non-ferrous metals is too well known to be mentioned. But this indigenous industry could not withstand the competition of western countries where primitive industry has been replaced by modern metallurgical industry whereas no similar change has taken place in India.

The argument that India lacks deposits of non-ferrous ores needs further scrutiny. Copper at one time used to be smelted in large quantities in Southern India, Rajputana and in the regions along the foot of the Himalyans, e.g., Kulu, Kangra, Sikkim and Bhutan. Interest has revived in the copper deposits of Khetri in Rajputana and in Sikkim and these two deposits should be immediately prospected. Lead and zinc are reported to exist in many places such as Singhbum, Central Provinces, Central India, Rajputana, Hazaribagh and Kashmir. Nickel and cobalt are known to exist in Nepal and tin is known to occur in Hazaribagh. India is particularly blessed with very extensive deposits of aluminium, magnesium and manganese ores. All that is required is to tap these sources in a planned and scientific manner and in the national interest.

Freedom of export of raw materials out of India has been the chief feature of India's mineral trade. It is no use concealing the fact that heavy profits are made abroad on minerals like manganese ore, mica, beryl, monazite and ilmenite sands of Travancore, etc., which are exported out of India in unrestricted quantities. Minerals are wasting assets and unrestricted export has deprived the country of many of its valuable minerals. The Travancore sands are a case in point where it is feared that because of the present rate of growth of exports the easily workable deposits will be depleted within two decades.

It is obvious that some sort of restriction should be imposed on export of Indian minerals. The material prosperity of the country depends not merely on the proper development of its resources but on their intelligent utilisation as well. Unlike forest and agricultural products, minerals cannot be replenished and their conservation and careful utilisation are of greater importance than those of the other natural resources of the country and consequently, need careful attention. It should not be construed that we take a narrow view regarding conservation of minerals for the country's exclusive use. On the contrary, we fully realise that modern industrial civilisation rests upon a raw material base that is unavoidably international, because of uneven geographical distribution of physical resources over the earth. India has for long been a principal source of raw materials. We have misgivings about this idea of free export of raw materials because we apprehend that foreign counties will menace our own industries with the goods manufactured with such raw materials and that in the ordering of our own internal economic life we shall be required to defer unduly to the needs of other countries. The war has completely altered the basic industrial position of the country and has given a powerful impetus to mineral processing and manufacturing industries. The mineral raw products of India thus enter a new phase of increased production and utilisation and other countries will be welcome to buy our manufactures rather than raw materials.

This leads us to the question of the direction and help the Government can give to the development of metal and mineral industries in India and the important questions of royalties, mineral tariff and taxation, the granting of leases for prospecting, protection to indigenous industries, etc. It is evident that unless the State can give proper direction and enunciate its policies in detail on the above questions, proper development of metal and mineral industries is hardly possible. At present in most of the Provinces and in the majority of the Indian States, the mineral rights vest absolutely in their respective Governments, except perhaps in the permanently settled estates in Bengal, Bihar and Orissa where the ownership of the mineral rights may vest in the holders of the land. So for, the Central and Provincial Governments and the Indian States have been functioning merely as the custodians of their mineral riches and as collectors of rent and royalties where they lease their mineral deposits to private enterprise.

There is no uniform procedure, policy, control or terms and conditions about granting of mineral leases or prospecting licenses. Consequently the development of India's metal and mineral industries has proceeded till now without any well organised plans or policies laid by the State to meet the growing needs of the country. No part or province of India can be regarded as self-sufficient either in respect of all minerals of industrial importance or in possessing the required mineral fuels, hydroelectric power, easy means of transport, adequacy of capital and such other facilities as are necessary for the progressive growth of metal and mineral industries. The best interests of India require full co-operation and concerted planning among her various provincial units, industrial associations, research organisations, Geological Survey Department, etc.

It should be realised that the cost of production of virgin metals cannot possibly be the same in all countries. The cost mainly depends upon the location and purity of ores. The cost of production therefore differs a great deal. The normal ruling price is the world parity of the cheapest production and other countries subsidise the industry to the extent of the difference between the world parity and cost of production.

## PRODUCTION AND FABRICATION OF NON-FERROUS METALS IN INDIA

The present position of the non-ferrous metal industries in India can be classified into the following four groups :—

1. Primary production or production of virgin metals from Indian ore deposits.
2. Secondary production or reclamation of metals and alloys from non-ferrous scrap.
3. Processing of primary or secondary metals and alloys into semi-finished materials like sheets, rods, pipes, tubes, wire, etc.
4. Fabricating and casting industries making finished products out of sheets, wires, etc., and castings out of primary or secondary metals and alloys.

1. *Primary Production*—The only primary metals produced in India are copper, aluminium, antimony and small quantities of lead. The present production is as follows :—

| | Annual production in Long Tons. | Percentage of present annual consumption. |
|---|---|---|
| Copper | 6,000 | 15 to 20 |
| Aluminium | 800 (from Indian Bauxite)<br>1,600 (from imported Alumina) | 30 to 40 |
| Antimony | 250 | 75 |
| Lead | 100 | less than 1 |

Evidently the present production of primary metals is not large. Copper was the only metal smelted in India before the War. Aluminium, antimony and lead only began to be produced during the War. Almost all the pre-war requirements of non-ferrous metals valuing over 10 to 12 crores of rupees per annum were met by imports. Appendix IV shows the imports of non-ferrous metals in India from 1923 to 1939.

2. *Secondary Production*—Even in countries producing large tonnages of virgin metals the recovery of metals from scrap is a highly organised industry. It was only during the War that India began to pay any serious attention to refining of scrap metals which were originally exported to countries like Japan. Several firms are now engaged in the refining of white and yellow metals.

3. *Processing of Primary or Secondary Metals* -The semi-manufacturing industry has largely been developed during the War, when sources of imports were totally cut off and the country was forced to rely on her own resources to meet her essential requirements. In spite of handicaps connected with imports of heavy machinery India was able to meet most of the defence requirements in respect of sheets, rods, wires etc. of aluminium copper and brass.

Most of the leading semi-manufacturing firms have plans for installing modern plant and equipment and we believe that within five years India will be able to meet all her requirements of semi-manufactures such as sheets, strips, foil, rods, tubes, shapes, wires and cables etc.

In this connection it may be pointed out that the Railways will continue to be one of the major users and semi-manufactures of non-ferrous metals. It is therefore essential that their non-ferrous foundries and workshops should be installed with modern plant and equipment for the proper and economic production of the various requirements. The Railways should moreover depend on indigenous industries for their requirements and not on imports from other countries.

4. *Fabricating and Casting Industries*—Large-scale fabricating industries are limited only to the manufacture of aluminium and brass utensils, Small non-ferrous foundries are scattered all over the country but only a few of them produce articles of industrial value.

It is obvious from a very brief survey of existing non-ferrous industries that up- to- date the development has been meagre and import was the chief feature of the metal industry of India. We have dealt with the development of each metal industry in detail in a subsequent chapter. However we cannot say that we have exhausted all the possibilities.

# CHAPTER I

## SUMMARY

The non-ferrous metal industry is closely tied to the mineral industry and hence a brief outline of India's mineral position as at present known is given. The survey however is confined to minerals and ores needed for non-ferrous metal industries. India possesses vast deposits of Bauxite, Magnesite, Beryllium, Manganese ore and Titanium ore. With regard to ores of Antimony, Chromium and Vanadium the position may be regarded as satisfactory. However very few workable ore deposits of the important industrial metals like Copper, Lead, Zinc, Tin, Nickel, Tungsten and Molybdenum have been discovered so far. This does not indicate that there are no ore deposits of these metals in India since India did maintain a prosperous indigenous non-ferrous metal industry in the past. Compared to U. K., Canada, Australia and South Africa, the progress of India's mineral industry during the last 50 years cannot at all be regarded as speedy or extensive. Among the causes of this tardy growth may be mentioned the following :—

1. Lack of policy and organised plans for prospecting, mining and utilisation of minerals.
2. Lack of effective state control, assistance and encouragement.
3. Absence of basic industries.
4. Lack of reliable information on the industrial application of minerals.
5. Lack of trained men and technical skill.
6. The haphazard mining of ore bodies with an eye for immediate gains leading to the rapid depletion and waste of the useful portions of the deposits.
7. Inroads of foreign firms who have taken up concessions for most of the important Indian minerals.

Indian minerals such as Mica, Beryl, Manganese ore, Monazite and ilmenite sands are freely exported at ridiculously low prices and huge profits made on them by outsiders in foreign countries. Minerals are wasting assets and the country is deprived of its mineral wealth due to these unrestricted exports. It is necessary to prohibit or at lease curtail unrestricted exports of these minerals.

Before the war, non-ferrous metal industry was almost non-existent in India and almost all her requirements were met by imports. To help the war effort a few refining and semi-manufacturing plants have been put up which should form the nucleus for a sizable non-ferrous industry in India. To-day India produces about 6000 tons of fire-refined Copper, 2,400 tons of Alumimium, 250 tons of Antimony and 100 tons of lead per year.

Compared to India's total consumption of non-ferrous metals this production is very insignificant with the exception of antimony.

## CHAPTER II

## GENERAL CONSIDERATIONS AND RECOMMENDATIONS FOR POST-WAR DEVELOPMENT OF NON-FERROUS METAL INDUSTRIES.

After careful discussion and consideration we have been able to arrive at certain conclusions regarding the lines on which post-war development of Metal and Mineral Industries should take place in India. All our subsequent recommendations regarding the development of individual metal industries are based on these general policies which in our considered judgment should be adopted if a rational development of Indian industries is to take place.

### Department of Metal & Mineral Industries.

In the first place we recommend that a Government Department of Metal and Mineral Industries with a Minister-in-Charge should be established. The following sub-sections headed by a Director should be under the Department of Metal and Mineral Industries :—

(1) Geological Survey of India.
(2) Department of Mines.
(3) Department of Metals.
(4) Mineral and Metal Research Bureau.
(5) Fuels and Refractories Department and such other Departments as are technically correlated to Mineral and Metal Industries.

### Metals and Minerals Board.

To assist the Minister-in-Charge of Metal and Mineral Industries we recommend the formation of a Metals and Minerals Board under the Chairmanship of the Minister-in-Charge, with members drawn from Industrial Associations. The Geological Survey of India, the proposed National Metallurgical Laboratory and such other associations and agencies as are vitally interested in the development of metal and mineral industries of India.

The functions of the Metals ond Minerals Board should be to discuss and decide the policies to be adopted with regard to the development of metal and mineral industries, such as control or prohibition of export of minerals, examination and revision of customs and mineral tariffs and taxation, granting of protection and assistance to indigenous industries, terms and conditions of granting mineral leases and prospecting licenses, proper utilisation of economic minerals, metals and their products, control of import and export of metals, desirablity of starting new metal and mineral industries, etc., The Department of Metal and Mineral Industries, should execute the policies formulated by the Metals and Minerals Board.

**Re-organisations of the Geological Survey of India.**

The first step in the development of non-ferrous metal industries should be in the direction of prospecting for ores and minerals. We feel that the Geological services at present available for these purposes are absolutely inadequate. The staff of the Geological Survey of India is too meagre and ill-equipped to undertake, in addition to its routine work of survey and mapping an intensive mineral survey and prospecting throughout India. We therefore strongly recommend an immediate and complete re-organisation of the Geological Survey of India and the establishment of a Mineral Survey Department—with adequate staff of competent geologists and mining engineers—to conduct intensive mineral investigations. We also recommend that the Geological Survey of India should have Regional Survey officers in all the major Indian States and Provinces.

We also hold that the Mineral Survey Department should help private prospectors in the way of technical advice, equipment, instruments, etc. and that the Government should also give financial help to private prospectors, if the prospects do not materialise into leases due to poor or insufficient quantities of ore deposits.

**Expansion of Indian School of Mines, Dhanbad.**

It is evident that any systematic prospecting of a vast country like India will need a large staff of trained geologists and mining engineers. At present only 7 out of 17 Universities in India have prescribed Geology as an optional subject for their degree examinations and only three institutions in India are offering courses in Mining or Metallurgy. We feel that the Universities should be encouraged to give extensive courses in Geology, Mining and Metallurgical subjects and recommend that the Indian School of Mines, Dhanbad, should be expanded and re-organised so as to give not only intensive education in Mining but also to make it the premier institution for training and research in Mining and Geology in all their various aspects. Mining, Geology and Metallurgical departments should also be added to the proposed four higher Institutes of Technology to be established in India.

**Reduction of Freight rates.**

The most serious disadvantage facing the proper development of the industries of the country is the high cost of transport of raw materials within the country. India's mineral reserves are scattered and for the purpose of manufacturing the majority of finished products it is necessary to transport large quantities of heavy and bulky minerals and fuels over great distances. For instance it is necessary to move seven tons of raw materials to produce one ton of aluminium. The freight rates on raw materials moved to the coast for export purposes are much lower than the freight rates on minerals which are being moved from mines to the smelters in India. In our opinion the reverse should be the case. Only one instance of comparative freight rates will suffice to prove that the cost of transportation is a great handicap to Indian industries. Ingot aluminium produced at Alwaye (in Travancore State) is rolled into sheets at Belur, Howrah. The freight rate for this distance of about 1,500 miles is Rs. 82/12/—per ton, and this rate it should be noted is a preferential rate. In Canada the freight rate from the big smelting area at Arvida (Quebec) to Vancoover (British Columbia), a distance of about 3,000 miles is $19.00 or Rs. 57/—per ton. Obviously the Indian rates are much too high. We recommend that the Government should immediately look into the possibilities of drastic reduction and adjustment of freight rates on industrial raw materials and finished products. Such revision would diminish in most cases the burden of tariffs, bounties or subsidies which would otherwise be necessary to protect the industries. The possibilities of developing inland water and road transport for carriage of heavy and bulky articles like minerals should also be investigated.

**Control of Mineral Exports.**

As indicated in the previous chapter India exports large quantities of minerals. We feel that no mineral should be exported without a compensatory return in the nature of much needed raw materials, machinery, skilled personnel, patent rights, etc. and recommend that :—

(1) Export of Beryl and ilmenite Sands of Travancore should be stopped altogether.

(2) Export of chromite, bauxite, manganese ores, etc., should be restricted while domestic treatment of these ores or their whole or part manufacture before export should be encouraged.

**Scope and Extent of Development of Non-ferrous Metal Industries.**

We feel that there is a vast scope for the development of non-ferrous metal industries in India, and recommend that :—

(1) Those metals whose ores are found in sufficient quantities in India should be smelted locally under Government protection, if necessary.

(2) Ores and other raw materials and virgin metals not available from Indian sources should be imported duty free.

(3) All semi-manufacture and fabrication of finished articles should be done in India.

**Ownership of Industry.**

We feel that the ownership of semi-manufacturing and fabricating industries should be left entirely to private enterprise except in cases where Government help is specifically solicited for special reasons. With regard to industries producing virgin metals which are not well established in India partial Government ownership would be necessary, whereas there might be other metals the production of which would have to be undertaken by the Government.

### Capital Requirements.

With respect to semi-manufacturing and fabricating industries we feel that sufficient capital would be available through private investment. It might, however, be necessary for the State to finance in part or wholly the production of some of the virgin metals.

### Technical Advice.

Expert technical advice from abroad would be necessary in the initial stages of starting new industries. We feel that the Government have taken the right step in encouraging and assisting students to go abroad for training. We however suggest that technicians and engineers who already have some experience in India should be sent to foreign countries for training in graduate schools and industrial plants for obtaining further experience in their own branches of engineering. These trainees on their return should be able to replace the teachnical personnel recruited from abroad in the initial stages of development. We also feel that in view of the recommendations that the Indian Railways should greatly increase the use of light metals for locomotives and coach construction, a number of Indian metallurgists and engineers would be sent from the Railways to the U. K. and U.S.A., to acquaint themselves with the latest development and technique for the utilisation of light metals in Railways.

### Co-operation with Foreign Firms.

We are of the opinion that co-operation with foreign firms regarding patent rights, technical help, etc. would be welcome. Foregin participation in capital should be discouraged as far as possible and should of course be limited to the extent of 30 to 40% only in cases where participation in capital is made a condition precedent to the co-operation solicited or where the help needed is not available from any other source without participation in capital. Management should however remain entirely Indian.

### Location of Industries.

We feel that the location of industries in most cases would depend upon the availability of raw materials, power, labour, freight rates, defence considerations, markets, etc. However, fabricating industries should be decentralised as far as possible subject to the production unit being economic. In this connection as already indicated we draw the attention of the Government towards the necessity of a downward revision of freight rates.

### Government Assistance to Industries.

We suggest that Government assistance to non-ferrous metal industries should be on the following lines :—

(1) Lifting of all import duties on scrap metals and on raw materials and virgin metals.

(2) Giving subsidies to high cost producers of virgin metals like copper, aluminium and antimony who have to compete with cheap imported metals.

(3) Levying import duties on semi-manufactures and finished goods to protect Indian industries.

(4) Lowering of inland freight rates and providing better transport facilities.

(5) Purchasing all the Government Stores required for railways, ordnance factories, telegraph and telephone, etc., of Indian manufacture unless the articles required are not manufactured or could not be easily manufactured in India.

(6) Making available to the industry the services of the proposed National Research Laboratories.

(7) Making available to the industry the services of expert personnel in the Planning and Development and other Departments of the Government of India.

(8) Giving financial and technical help to private prospectors.

**Government Controls.**

We feel that some measure of Government control of the industries would be necessary to achieve production targets set from time to time and to limit excessive profits. In cases where assistance is granted to the industry, in some form or another, suitable controls will be necessary to see that the assistance is not misused. In general the policies outlined in the "Statement of Government's Industrial Policy" are considered quite adequate.

**Organisation of Different Units of Industry.**

We recommend that the different units of industry should be organised in one or more industrial associations. These associations should comprise of all branches of the industry like producers of virgin and secondary metals, semi-manufacturers, fabricators, etc., and should have an unified policy to enable them to express the sentiments of the industry as a whole. Cartelisation of the industry is undesirable and should not be allowed to develop.

**Stages of Development.**

The first step towards the development of industries producing virgin metals should be in the direction of a comprehensive prospecting for metallic minerals and ores and determination of ore reserves in India. The deposits which have already been discovered should be further prospected. This should be followed by provision of adequate facilities for power, transport of raw materials, etc., followed by actual erection of plants at suitable sites for reduction of ores. Possibilities of reducing imported ores should also be looked into.

Cheap power is the pre-requisite of all industries. Various power projects contemplated for different regions on the recommendation of the Central Technical Power Board should be duly advertised and requirements of industries registered beforehand. This will enable the promoters and industrialists to locate and start metal and mineral industries with some confidence.

**Export Market.**

We recommend that export markets should be developed only for those metallic manufactures which can be produced in abundance without unnecessarily depleting the country's ore reserves or affecting the country's markets.

**Cottage Industries.**

It is difficult to conceive the manufacture of metals on a cottage industry basis. However the final fabrication of metallic products could be encouraged by the 'Cottage Industries', and we recommend that such industries should be run on a co-operative basis and all possible help should be given to them in the nature of cheap raw materials, technical advice and literature, machinery, training of workers, etc.,.

**Capital Goods.**

We recommend that Government should lift all import duties on capital goods unitl such time as India could manufacture her own requirements. Government should also assist imports of capital goods from countries where they are readily available. Capital goods which can however be manufactured locally should not be allowed to be imported. We feel that there will be a good deal of surplus equipment available from war plants of the United States, Germany and Japan and before ordering new equipment enquiries should be made as to the availability of this surplus equipment. There will also be some surplus equipment available from Indian Ordnance Factories, particularly the Ambernath and Katni Ordnance Factories, which should be leased or sold to established non-ferrous metal manufacturers if such equipment can be used by them. Government's intention as to the disposal or utilisation of the existing non-ferrous processing ordnance plants, which may be surplus, should be clarified as early as possible to avoid duplication of plants by imports.

**Indian Standard Specifications.**

At present there are no adequate and comprehensive specifications for the guidance of manufacturers and buyers of metals and alloys. We feel that it is necessary to co-ordinate Indian Railway and Ordnance specifications under one schedule and recommend that Government should appoint a Committee to devise Indian Standard Specifications for metals and alloys and that all Government Departments and industrial concerns should exclusively follow these specifications when devised.

**Industrial Deputation.**

We are of the opinion that before any large scale plans for the development of non-ferrous industries of India are undertaken a deputation of metallurgists, industrialists, technicians, and others connected with and interested in the development of such industries should be sent to the U. K. U. S. A., Germany and Japan with Government assistance, to study the latest developments and technique of metal production. In the modern competitive era, it is absolutely essential that the industry should be in the closest touch with new developments and full advantage should be taken of the technical advances made during the war to develop Indian industries on modern lines.

**Transition Period.**

We feel that Government control on non-ferrous metals should be relaxed gradually and re-modeled during the transition period. There is bound to be a large civilian demand for all kinds of goods in the period immediately following the war and Government must do everything in its power to see that foreign competition is not allowed to capture the Indian market. The formation and deliberations of a permanent Tariff Board to revise and modify the present tariff rates on imports will take some time. We propose that in the interim period Government should continue to give support to the non-ferrous industry as was done during the war. Specifically we recommend that :—

(1) The scrap metals in Government stocks should not be auctioned but distributed to established refiners and semi-manufacturers according to the capacities of their plants.

(2) Government should not issue licenses for import of metals without consulting representatives of Indian Non-Ferrous industrial and commercial interests and only such quantities of metals as are likely to be required in excess of indigenous production should be allowed to be imported.

(3) Facilities should be provided for duty free imports of scrap metals and capital goods from countries where they are readily available.

(4) Export of scrap metals should be regulated.

(5) Government should instruct their Purchase Departments to extend their purchase preference to products manufactured by Indian industry.

(6) No long term orders for materials required for postwar plans of railway expansion, power development etc. should be placed in foreign countries, unless it is found on investigations that such materials will not be produced in India in the near future.

## CHAPTER II

## SUMMARY

This chapter outlines general considerations and our recommendations regarding the development of non-ferrous metal industries in India. In order to co-ordinate the various activities connected with the development of metal and mineral industries we have recommended the formation of a Department of Metal and Mineral Industries at the Centre with a Minister-in-Charge who should be assisted by a Metals and Minerals Board with members drawn from Industrial Associations, Geological Survey of India, the proposed National Metallurgical Laboratories, etc. The functions of this Board would be to discuss and decide the policies to be adopted with regard to the development of metal and mineral industries. The Department of Metal and Mineral Industries should have the following sub-sections each headed by a Director :— .

(1) Geological Survey of India.

(2) Department of Mines.

(3) Department of Metals.

(4) Mineral and Metal Research Bureau.

(5) Fuels and Refractories Department.

and such other departments as are technically correlated to mineral and metal industries.

The present facilities for mineral survey and instructions in Geology, Mining and Metallurgical subjects are inadequate and we recommend a complete and thorough reorganisation of the Geological Survey of India and the School of Mines, Dhanbad. We also recommend that Geology, Mining and Metallurgical departments should be added to the proposed four higher Institutes of Technology to be established in India.

One of the handicaps in the development of Indian industries is the high cost of inland transport. We feel that compared to other countries Indian railway freight rates are very high and recommend drastic reductions. Lowering of freight rates would also diminish the burden of tariffs, subsidies, etc., which would be necessary to protect the industries.

Free export of minerals from India is viewed by us with misgiving. No mineral should be exported without a compensatory return and export of minerals such as Beryl and Ilmenite sands of Travancore should be stopped altogether. Export of Chromite, Bauxite and Manganese ores should be restricted while domestic treatment of these ores should be encouraged.

India is capable of manufacturing all her requirements of semi-manufactures such as sheet, foil, wires, cables, rods, tubes, etc. Regarding virgin metals India should produce those metal, ores of which are found in sufficient quantities within the country while raw materials for the manufacture of other metals should be imported duty free. It will not be necessary for the Government to own any industry if enough private capital is forthcoming. However, partial Government ownership may be desirable in cases of industries producing virgin metals which are not well established in India. Co-operation with foreign firms regarding patent rights, technical advice, capital goods, etc., would be welcome. Foreign participation in capital investment should be discouraged as far as possible and in cases where foreign help could not be made available without participation in capital, it should be limited to the extent of 30 to 40 per cent only. Management should remain entirely Indian.

Government assistance to industries should be in the nature of subsidies to high cost producers of virgin metals. Imports of raw materials and scrap and virgin metals should be duty free as far as possible. Import duties should be levied on such semi-manufactures as are produced in India. Lowering of railway freight rates and purchase of Indian made goods by Government purchase departments will give added impetus to indigenous industries.

Government control on non-ferrous metal industry will be necessary particularly to see that production targets are reached and that any assistance given by the State is not misused.

## CHAPTER III

## NON-FERROUS METALS AND THEIR DEVELOPMENT IN INDIA

In the following paragraphs we have reviewed all the important industrial non-ferrous metals and have made our recommendation regarding their future development.

### COPPER

**Uses.**

The application of copper and copper alloys covers a wide field and there is hardly any industry in which these materials in one form or another are not employed. Distribution of their uses in normal times is confined under the following heads :—

1. Electrical manufactures.
2. Buildings.
3. Automobiles.
4. Telephone and Telegraphs.
5. Shipbuilding.
6. Railway equipment.
7. Other uses including kitchen utensils, coinage and general engineering.

The main features of pure copper are high electrical and thermal conductivity, fair strength and excellent corrosion resistance. The various copper alloys possess many of the characteristics of copper, but they are in general harder and stronger and have lower conductivity. The main copper alloys are brasses (alloys of copper and zinc), Bronzes (alloys of copper and tin), Monel metal (30% cu.+70% Ni.), Nickle Silver (alloys of copper, zinc and nickle), Beryllium Copper (copper plus 2 to 4% beryllium) and Duralumin (alloys of aluminium with about 4% copper).

**World Production and India's Share.**

The largest producers of copper are the United States of America, South America, Canada, Northern Rhodesia and Belgian Congo. The world's output in 1938 was 2,031,000 metric tons. India produces about 6,000 tons of fire-refined copper per year, all of which is converted into brass sheets.

**International Controls.**

The history of copper after the first world war was similar to that of many other basic commodities. World producing capacity increased with the development of new low cost producers, while world consumption failed to keep pace even before 1929 and fell sharply during the depression. In the face of this situation prices were maintained at an artificially high level for a time by a world cartel. They then collapsed disastrously.

In 1926 the U. S. producers organised Copper Exporters Inc., who took foreign firms as non-voting members. The purpose of this organisation was to eliminate middlemen, prevent manipulation and " stabilise prices ". The stabilisation of prices turned out to mean stabilisation upwards which at one time went up to 24 cents a pound. This of course came crashing down when the controls cracked. In May 1932, most of the foreign firms resigned from Copper exporters Inc., and in 1935 came to an agreement which provided for a co-operative marketing and price policy among the non-United States producers. The participants in the International Committee were all low cost producers who concentrated on increased production rather than higher prices. In January, 1937, the Cartel removed all restrictions on output announcing at the same time that should the prices fall far below the current level, restrictions would be resumed. Copper prices have since risen strikingly.

**Imports of Copper and Brass into India.**

Imports of copper both wrought and unwrought excluding telephone and telegraph wires—amounted to about 8,500 tons in 1938-39 and that of brass about 16,000 tons in the same year.

**Consumption of Copper in India.**

The total yearly consumption of copper in India is rather difficult to estimate because copper is imported in several alloys, electrical equipment, machinery, etc., besides being imported in the pure form either as ingots or as wrought copper. A large quantity of secondary copper is also used. A fair estimate of pre-war consumption of copper in all forms would be between 35,000 and 40,000 tons per year.

**Indian Copper Ores.**

Copper pyrites (Chalcopyrite) is the principal ore of copper. It is fairly widely met with in India and supported in the past, extensive mining operations for the production of copper at numerous centres. Enormous heaps of slag testify to the size of the old copper works in Khetri and other places in Jaipur State ; Singhbum and Baragunda (Near Parasnath Hills) ; in the Sikkim State ; Kumaon and Kangra Valley in the Himalaya ; and in Mysore State. At all these sites copper was smelted from pyritous ores for the manufacture of principal alloys of copper, viz., brass and bronze. Only one mining concern in Singhbum, to-day produces about 6,000 tons of copper annualy by treating about 350,000 tons of this ore, the copper content of which is about 2·5%. In view of the lack of concentration of copper pyrites in workable loades, veins or masses, the resources of India in this mineral may be considered as small, so far as at present known. Regarded as sources of sulphur they have played very little part in Indian industry. Discovery of sulphide ores, of even poor grade, would render possible not only the extraction of sulphur but by liberating this by-product, make the extraction of the associated metals economically feasible. In this regard we emphasise the need of Government initiative in prospecting the copper belts of Sikkim and Khetri which seem to be the most promising.

**Future of Indian Copper Smelting Industries.**

The existing firm producing fire-refined copper does not anticipate any increase in their production in the near future. In any case they may be considered manufacturers of hot rolled brass sheets rather than of copper since they cannot hope to compete in the market with imported copper but are able to compete successfully in the field of brass sheet sheltering as it were behind the protective tariff on brass sheet imports and duty free zinc.

We feel after examination of pre-war copper trade and anticipation of post-war development of electrical and other industries that the average annual requirements of copper during the first five year period after the war will be as follows :

| | | |
|---|---|---|
| Copper for copper base alloys | ... | 25 to 30,000 tons per year. |
| Electrolytic copper | ... | 16 to 20,000 ,, ,, ,, |

Against these requirements the production of 6,000 tons of fire-refined copper seems very insignificant and we make the following recommendations for increasing the production of virgin copper in India :

1. Immediate and thorough prospecting and exploratory work of the Sikkim and Khetri Copper deposits should be taken in hand and if the deposits are found promising their exploitation should not be delayed.

2. Negotiations should be undertaken with the Governments of Burma and other countries as to the possibilities of importing their copper concentrates or ores with a view to smelting them in India.

3. Lifting of all import duties on virgin copper and copper scrap and giving a subsidy to the indigenous producers if they are unable to compete with imported copper.

4. Encouraging secondary copper production by giving facilities for collecting, segregating and transporting scrap and technical guidance to refiners of scrap.

5. The production of electrolytic copper out of copper and copper alloy scrap is immediately possible and should be encouraged by the State.

## COPPER AND COPPER ALLOY SEMI-MANUFACTURES

### Brass and Copper Sheet and Strip.

Yellow metal sheets are consumed in large quantities in India for the manufacture of utensils, stoves, sterilisers, etc. At present though there are several firms producing brass sheet, only one commercial plant has up-to-date equipment for hot rolling of brass sheets and produces abous 8,000 tons of sheets up to 21 S. W. G. They are intending to put up a new cold mill which will bring their total production of brass sheets to about 12,000 tons per year. The total war time production of yellow metal sheets amounted to about 10,000 tons per year. This means that at present India produces less than half her pre-war consumption of brass sheets. We have set the peak production target for brass sheets and strip at 35,000 tons per year during the first five year period of development and for copper sheet and strip at 6,000 tons. In the circumstances it will be necessary to encourage one or more of the firms at present engaged in rolling brass sheets to import up-to-date rolling mills, melting furnaces and auxiliary equipment to produce sheet and strip upto 30 S. W. G. It is felt that some of the existing rolling mills will have to be scrapped in view of the fact that these mills have outlived their usefulness. We suggest that the production of brass sheets should be encouraged on a regional basis and that modern rolling plants should be erected one in the west, preferably near Bombay, one in the South (near Madras) and one in the United Provinces. The existing plant at Ghatsila in Bihar will take care of the requirements in the eastern zone. The cost of each plant producing about eight thousand tons of sheets would come to about 50 to 60 lakhs of rupees.

**Brass and Copper Rods, Bars, Shapes and Tubes.**

Most of the requirements of brass and copper bars and rods during the war were met by indigenous producers and there are several firms all over India who hot and cold roll rods and bars. The quality of these products, however, leaves much to be desired and can be attributed to the poor quality of equipment used for the manufacture of these products. The necessity of an extrusion press for these products is keenly felt and we recommend importing one 2,000 ton extrusion press to meet the demands for rods, bars, shapes, etc., of brass and copper. This extrusion press can also be used for the manufacture of tubes. Excepting one firm who produces copper tubes up to size 1/2″ outside diameter by rolling over a mandrel, there is no one who makes tubes in India. Besides the extrusion press mentioned above, tube reducing machines, draw benches, etc., will have to be imported for manufacture of tubes. However, in the event the extrusion presss at Katni Ordnance Factory be made available to the industry we feel that it will not be necessary to import another one immediately as this press would be able to meet the immediate requirements of the country.

**Brass and Copper Wire.**

Large quantities of brass and copper wire are used in India in Jari manufacture, in making rivets, copper tacks, screw wires and nails and also for packing, binding and many other purposes. Electrolytic copper wires and cables have innumerable uses in the electrical engineering industry.

During the war the production of cables and wires both bare and insulated has increased considerably. We feel that the production of wires for electrical purposes will be best tackled by the Electrical Industries Panel. We would, however, record our opinion that there is no reason why all the Indian requirements of wires and cables should not be met by indigenous producers.

As regards wires not used for electrical purposes we feel that the present wire drawing mills are very poorly equipped. Coils weighing only up to seven pounds each are produced at present whereas imported coils weigh over a hundred pounds each. Heavier coils have an advantage when wire is to be used in automatic machines. With the present quality and price of the wire produced it will be difficult to compete with imported wire and we suggest that existing firms be encouraged to install modern continuous wire drawing equipment. Diamond dies and electric annealing furnaces will also be necessary for producing good quality wire.

**Protection to Fabricators.**

We feel that all the requirements of semi-manufactures and fabricated articles of copper and copper alloys can be met by Indian producers. The railways are perhaps the largest users of non-ferrous metals in peace time and it should be possible to meet all their requirements through indigenous manufacture. We repeat that :

1. There should be no import duty on virgin copper.
2. Heavy import duties should be levied on all semi-manufactures which are indigenously produced at reasonable costs.
3. Subsidies should be given to indigenous producers of virgin copper if their cost of production is higher than that of imported copper.

## ALUMINIUM

**Uses.**

The coming age is the age of light metals and aluminium is destined to play an important role in the future development of almost all branches of industry. Aluminium can be classed as a general purpose metal and its uses both as metal and in the form of strong alloys are innumerable. They are in the field of transportation—air, road, rail and water—for overhead transmission lines, in the chemical, brewery and food industries generally, in building and architecture, for packing and insulation in the form of foil, for painting in the form of powder and paste and in the kitchen in the form of utensils. Aluminium can be anodized and dyed giving very pleasant and striking decorative colours. Anodized aluminium is also used as reflectors and has remarkable corrosion and abrasion resistance.

The most valuable property of aluminium is its lightness combined with corrosion resistance and good electrical conductivity. Owing to its lightness for equal conductivity, the weight of aluminium required for a conductor is about 50 per cent that of copper.

Aluminium is seldom used in the pure form for structural purposes but is alloyed with copper, manganese, silicon, magnesium, nickel, zinc and other metals to produce a series of alloys with widely varying properties. The so called " strong alloys " of ' duralumin ' type are generally alloys of aluminium with up to 4 per cent copper and minor quantities of magnesium and manganese. The " Y " and " RR " alloys contain nickel along with the above alloying elements. These alloys develop their strength on heat treatment. Appendix V gives most of the uses of light metal alloys both aluminium and magnesium.

### International controls.

The aluminium industry during the half century of its existence has always been dominated by a small number of firms owing to the large investment required for the electrolytic separation of the metal, to the limited supplies of the economic raw materials, to the complexity of production processes and the opposition of established interests against the rise of new ventures. Before the first world war four companies in Europe and one in America controlled the output. The war saw tremendous development in aluminium industry and because of its importance in modern warfare governments in different countries fostered domestic aluminium industries. In 1931 a strong cartel was set up and incorporated as the Alliance Aluminium Company of Basle. It rigidly limited output by setting up quotas to be enforced by periodic audits. The life of the cartel was to be 99 years but we understand that the cartel was dissolved during the war period.

### Imports of Aluminium in India.

The pre-war imports of aluminium have varied considerably from year to year. The highest in 1929-30 was about 8,500 tons. In 1938-39 it was about 3,000 tons.

### Indian Ores of Aluminium.

India possesses enormous resources in aluminium, the reserves of high grade bauxite, the principal ore, being roughly estimated at 250 million tons. Proved workable occurrances are those of Jubbulpore and Balaghat Districts of C. P., Belgaum and Kolhapur, Thana and Khaira in Bombay ; Ranchi Plateau in Bihar and Shevaroy Hills in Salem, besides several occurrences in Central India, Kashmir and elsewhere.

The majority of Indian bauxite deposits are easily workable by simple open cast methods of quarrying, though transport is a problem in connection with most of the occurrences and the freight charges in the present day transport conditions are prohibitive. In composition the Indian bauxites are of a high grade and suitable for modern methods of purifications and reduction. Titanium can also be obtained by the treatment of these ores..

**Production of Virgin Aluminium in India.**

Two companies are at present engaged in the production of virgin aluminium, one of which uses imported aluminalumina and reduces it in Travancore State where hydro-electric power is available. However, they are now putting up an alumina plant to treat Indian bauxite. The complete plant of the other company is in Asansol and uses steam power. The total Indian production at present is about 2,400 tons per year. The reduction of aluminium is an electro-metallurgical process for which cheap power is a necessity. We are given to understand that the development of the virgin metal producing industry will be dealt with by the Electro-Chemical Industries Panel. However, aluminium being the most important non-ferrous metal we offer the following comments.

**Suggestions for increased use of Aluminium in India.**

We cannot lay enough stress on the importance of increasing the production and use of aluminium in India. There is an abundance of raw materials available for its production and since India is known to be deficient in ores of other industrial metals like copper, zinc, lead, tin, etc., it is obvious that the future of Indian industry is bound up with the development of its aluminium industries. Aluminium and its alloys can be easily and with advantage substituted for most of the other non-ferrous and ferrous materials. Among the uses to which India can immediately and advantageously put aluminium we suggest the following :

1. *Electrical Transmission Lines :* Large quantities of transmission line wires and bus-bars will be required for the proposed power schemes. Steel cored aluminium cables have been successfully used in Europe and America for power transmission and they should be used in India wherever possible.

2. *Rail and Road Transport :* We understand that the railways have under planning a new expansion programme which will require hundreds of passenger coaches and goods wagons. The use of aluminium coaches in America and Europe have shown that a considerable economy is possible by the use of aluminium not only by increasing pay load but by reducing maintenance costs, etc. We strongly recommend that the Indian railways should follow the times and greatly increase the use of aluminium in locomotive and coach construction.

Passenger buses in India can also use aluminium bodies to advantage. In this connection the all aluminium car contemplated by American and British Car manufacturers is of importance. Future Indian automobile manfacturers will have to depend mostly on aluminium alloys for the construction of their cars.

3. *Numismatic uses of Aluminium :* Many countries have used pure aluminium, aluminium bronze and aluminium manganese (1.5% Mn.) alloys for coinage. The wear resistance of these coins have been quite satisfactory. In view of the Government's plan of decimalising Indian coinage the Indian Mints should be advised to look into the possibilities of using aluminium coins, thus avoiding the use of metals in which the country is deficient. That the people might object to such light coinage is no justification for not giving them a trial, If the people could reconcile themselves to having holes in their coins they should easily reconcile themselves to light alloy coins.

4. Importance of manufacturing aluminium alloys of duralumin type could not be over emphasised. The technology does not present any undue difficulties and once the preliminaries are ironed out the popularisation of aluminium and its alloys for all kind of transport vehicles, structures requiring high specific yield strength, etc., will not be difficult. We feel that the Government can help a great deal in making the nation aluminium minded by initiating the uses of aluminium on railways, etc.

**Target for Aluminium Production.**

We are given to understand that when the full capacity of the existing reduction plants is attained about 8,000 tons of virgin aluminium will be available. We have set the minimum target for average annual production for the first-five years at 15,000 tons and feel that this production can be easily realised by starting new reduction works. The extension of the old power stations and contemplated new power schemes will make enough power available. We also feel that the production of 50,000 tons per year at the end of fifteen years is within the realm of possibility.

**Protection to the Industry.**

The present cost of production of virgin aluminium is stated to be two to three times as high as in Canada or the U. S. A. We are not in a position to ascertain the reason why it is so and feel that it should be possible to reduce the cost considerably. However, the industry will need some protection in order to survive foreign competition and we recommend giving a subsidy to the producers to make up the difference between landed cost of imported aluminium and the cost of local production. Imposition of an import duty will work to the detriment of semi-manufacturers and consumers who cannot rely on the present producers to supply all their demands. We therefore strongly urge that there should be no duty on the imports of virgin aluminium but that the quantity of imports should be controlled and exporting countries should be prevented from dumping their aluminium in the Indian market. Also in order to encourage Indian semi-manufacturers of aluminium, import duties should be levied on all the semi-manfactures as are made at present and similar duties should be levied on such semi-manufactures, as wires and cables, etc., not at present manufactured, as soon as their manufacture is started.

We are of the opinion that the Government will have to keep a strict vigilance on aluminium trade in India and not allow foreign competitors to capture our markets in the initial stages when the demand for aluminium products will be very large. On the contrary efforts should be made to utilise this opportunity of large demands to encourage Indian enterprise to undertake the manfacture of aluminium and its alloys, semi-manufactures, etc.

We regert that no universities or technical schools in India give courses in the use and technology of light metals. We strongly recommend the inclusion of special courses in such subjects in all the universities and technical colleges.

**Aluminium Semi-manufactures.**

At present only one up-to-date rolling mill (near Calcutta) producing about 1,600 tons of aluminium sheets per year is in operation. We regret we have been unable to obtain any information regarding a new mill operating in Asansol. Several other firms in Bombay and elsewhere also roll aluminium sheets on the same mills on which they normally roll brass and copper sheets. It is feared that inferior products tend to ruin the reputation of Indian industry and such practices should be discouraged as far as possible.

We have set the following targets for the semi-manufactures of aluminium :—

| *Articles.* | | *Annual Production Targets during the first Five Years : in long tons.* |
|---|---|---|
| Sheets and circles | ... | 10,000 |
| Foil | ... | 1,500 to 2,000 |
| Tubes, rods, shapes, etc. | ... | 2,000 |
| Wires and cables | ... | 5,000 and up |
| Castings (Industrial) | ... | 2,000 |
| Powder | ... | 1,000 |

**Sheets and Circles.**

The present production capacity for high quality specification sheets can roughly be estimated at 3,000 tons per year. We feel that two up-to-date rolling mills—one in South India and the other in the Central or

Western India—each producing 3,500 tons of sheets per year should be put up.

**Foil.**

The use of aluminium foil is increasing and a modern foil mill should be immediately started to meet the demands of the tea and cigarette industries and for other wrapping purposes. We understand that one mill rolling tea-lead in Calcutta is changing over to rolling aluminium foil and will produce about 700 tons of foil for tea-chest lining. Another foil mill rolling foil for wrapping purposes needs to be put up.

**Tubes, Rods, Shapes, etc.**

The increasing development of chemical and engineering industries will need a large quantity of aluminium tubes, rods, etc. Though pre-war imports of these commodities have been negligible we anticipate a large demand and suggest that an extrusion press and auxiliary equipment should be imported for the manufacture of these products. Tube reducing machines, draw benches, etc., will also be required. The extrusion press can also supply wire bars for wire mills.

**Wires and Cables.**

As mentioned before aluminium cables are replacing copper cables for transmission lines, etc., and to meet the demands of the electrification schemes at least one wire drawing and cable stranding plant should be put up immediately, or one of the factories producing copper cables can be converted to aluminium cable manufacture. Aluminium ingots for this purpose, if not immediately available in India, could be imported.

**Castings.**

A good many foundries make aluminium castings. We suggest that the possibilities of making aluminium die-castings should be thoroughly investigated.

**Powder.**

Aluminium paint and paste is extensively used in India and the manufacture of aluminium powder required for these purposes should be undertaken in India.

**Aluminium Fabricating Industry.**

Aluminium Fabricating Industry producing hollow-ware, kitchen and dairy wares, etc., is firmly established in India. The tendency of producing wares out of thin gauge sheets should, however, be discouraged.

It is desirable to encourage the manufacture of utensil and small castings on cottage industry basis. The Provincial directors of industries can encourage such manufactures in villages and small towns. Small spinning lathes and power presses could be loaned to individuals and raw materials in the nature of circles or ingot metal could be supplied to them from village co-operatives.

## LEAD

### Uses.

The corrosion resistance of lead is one of its important properties. Combined with the high resistance to chemical attack is the ease with which the metal can be shaped and moulded, while its low melting point makes jointing a simple operation. Lead is thus used for a large variety of purposes for chemical plants where its resistance to attack can be further increased by small additions of other metals like copper, nickel and tellurium. Ternary lead alloys with small amounts of calcium and alternatively either antimony or tin have strength almost twice that of pure lead. Antimonial lead alloys up to 30 per cent antimony have a variety of uses in chemical plants. Lead calcium alloys up to 0.1 per cent calcium are used for grids and plates for storage cells, cable sheathing and other purposes. The single use which consumes the largest amount of lead is the manufacture of accumulator plates, and this is followed by pipes and foil. Lead is also an essential component of solders, type metals and bearing metals. Lead compounds are extensively used as pigment (white lead, red lead, etc.).

### International Controls.

No attempt was made by the lead producers after the first war to come to any agreement till 1931 when non-United States producers came to an agreement to cut down production by 20 per cent. In March of the next year the Cartel dissolved and prices dropped sharply. The combined effort of sterling devaluation and the imposition of a British tariff on non-Empire lead, destroyed the Cartel. Nevertheless restrictive measures by the International Zinc Syndicate indirectly imposed partial restriction on lead due to the fact that lead and zinc are often mined together from the same mines. In 1935 a new arrangement was arrived at by the lead producers. This was a very flexible arrangement which did away with the quota system of production but agreed not to increase output without due notice.

### Indian Imports of Lead.

India imported about 7,500 tons of lead both wrought and unwrought in 1938-39. Practically no indigenous production was recorded.

### Indian Lead Ores.

Although lead ores—chiefly galena—are known to occur at a large unmber of places in India and were mined on a considerable scale at these places in the past, no large deposits have so far been located. The known occurrances of lead are those of Hazaribagh in Bihar, Manbhum and Drug Districts of C. P., and Datia and Gwalior in Central India. A good proportion of these ores are argentiferrous, yielding a few ounces of silver per ton of ore. All these, however, require thorough prospecting and exploration before they can be discarded as uneconomic to work. The only locality which has figured in the Indian mineral production returns is Jaipur State in Rajputana where small quantities of lead ore are mined. Small quantities of lead are also associated with the zinc ores of Zawar in the Udaipur Districts.

**Indian Lead Production.**

A small lead smelter was started during the War in Bihar after a great deal of difficulty mainly connected with ore supplies. The future possibilities of lead smelting are difficult to assess in view of the incomplete knowledge of the future ore supplies. The present production of about 100 tons a year is very insignificant.

**Lead Pipes.**

The 1938-39 import of lead pipes was about 500 tons. A lead extrusion press has been installed in Calcutta during the war and at present produces 500 tons of lead pipes from 3/8" to 6" internal diameter. The production can be stepped up to 600 to 800 tons if required. We feel that there is no immediate need for installing another extrusion press for lead pipes. However, a press could be installed in Bombay if the demands increase considerably.

**Lead Sheets.**

Chemical and tea industries and building construction consumes the main bulk of lead sheets. So far the Indian producers have not attempted to roll sheets wider than 3 feet. Demands for sheets up to 8 feet width are considerable and are likely to increase in the future. A mill producing wider sheets would be welcome by the chemical industries. Aluminium foil can be advantageously used for tea chest lining instead of lead and this change should be immediately effected. We understand that a Calcutta concern is switching over from lead to aluminium foil production.

**Accumulator Plates.**

Accumulator plates required for secondary batteries are produced at Bangalore, Bombay, Calcutta and other places. It is possible to produce all the Indian requirements indigenously and we presume the Electrical Industries Panel will look into the matter.

**Suggestions for Development of Lead Industry.**

Before the war most of the lead requirements were met by imports from Burma. It is difficult to say how soon Burma lead will begin coming into India again. In any case the last war has shown that a lead smelter is absolutely essential for India. The chief lead deposits of Rajputana States and Bihar need to be thoroughly prospected and we feel that a metallurgical centre should be started in Rajputana, where deposits of lead, zinc and copper are known to occur. The present producers are carrying on prospecting and mining operations at Keraikella (Seraikella State) and Chauth-ka-Barwara (Jaipur State). The smelter is located at Katrasgarh (Bihar). They anticipate a large output of ore and intend to instal a modern blast furnace capable of producing about 1000 tons of lead per month. The initial expenditure for proving the ore reserves is bound to be heavy and we recommend that the Government should help the industry along the following lines.

(1) Government should undertake the proving of the mines leaving the subsequent mining operation to the firm. Part of the initial cost of proving the mines could be charged to the firm if the ore reserve is proved to be sufficiently large to justify economical working of the mines for a number of years. If the Government does not intend to undertake proving of the mines they should advance enough money to the firm to undertake the work themselves.

(2) Freight rates on ores and raw materials needed for lead smelting should be so adjusted that they do not exceed 10 per cent of the present value of the metal. If, however, the price of lead comes down to Rs. 250 per ton (pre-war price) then the freight rate should not exceed 5 per cent of the value of the metal in the ore.

(3) Government should facilitate import of plant and machinery required for lead smelting.

(4) If the above assistance is given by the State it is hoped that the industry will be able to stand on its own legs. However, if the market becomes highly competitive due to serious unloading of accumulated stocks or other causes it may be necessary to protect the infant industry by subsidies.

(5) If Indian ore reserves are proved to be unsatisfactory Government should facilitate imports of ores or concentrates from Burma and other countries.

We anticipate that India will consume a peak of about 25,000 tons of lead per year within the first five post-war years. We feel that most of these requirements will have to be met by imports unless the present firm can produce India's requirements by 1950. We recommend that so long as India does not produce enough lead all the lead imports should be free of duty to enable indigenous producers of sheet, pipe, pigments, etc. to survive foreign competition.

## ZINC

**Uses.**

The most important property of the metal to which the bulk of its application is due is its high resistance to atmospheric corrosion. It is used largely for the protection of iron and steel in the form of galvanised sheet and is also applied by spraying and sherardising. Other major applications are in the preparation of brass, bearing metal, as zinc base die castings and as zinc plating. Zinc compounds are extensively used in the textile, die and paint industries.

**International Controls.**

The modern history of zinc industry has been the history of two distinct markets ; that of U. S. A. and that of Europe with the rest of the world. Cartelisation was established as early as 1885, the Belgian and German firms having organised the International Zinc Syndicate. With several reorganisations the Cartel survived until the beginning of the 1st world war. The industry was disorganised in the years after the war till in May 1928 when the European Zinc Cartel was organised. The Cartel broke down in 1929 and in 1931 a new world Cartel was set up which included all but U. S. Producers. The Cartel was extremely unstable and broke down at the end of 1934 mainly due to Great Britain's application of a duty on non-Empire zinc and Germany's introduction of a premium to domestic zinc producers. In 1936 another agreement was arrived at to control production and prices.

**Indian Consumption and Imports.**

An estimate of India's pre-war consumption is as follows :

(1) Galvanising iron and steel articles including manufacture of sheets 16,000 to 18,000 tons per year.

(2) Manufacture of non-ferrous alloys, e.g., brass, bronze, bearing metals, etc., 6,000 to 8,000 tons per year.

(3) About 30,000 tons of zinc chloride obtained mostly from zinc residues, were also used in the textile and dye industries.

(4) Manufacture of zinc oxide consumes about 3,000 to 4,000 tons of zinc per year.

The 1938-39 imports of zinc amounted to about 26,000 tons. There was no indigenous production.

We feel that the peak annual consumption of zinc in all forms during the first five-years will be around 50,000 tons.

**Indian Zinc Ores.**

India's present known deposits of zinc are confined to a few abandoned mines in the vicinity of Zawar (Udaipur State) where the existence of mounds of slag and debris suggests either that the deposits were of large size or that the mines were worked for many centuries. It appears that the zinc mines were worked prior to the 18th century and then abandoned. With the exception of the occurrence of zinc sulphide ores in the Riasin District in Kashmir State, there is no other site known in India where workable deposits of the metal occur. The Bawdwin Lead-Zinc mines of Central Burma produced on the average 60,000 tons of zinc concentrates yearly and supplied the Indian demand for the metal. The Zawar mines were lately reopened by the Geological Survey of India with a view to explore the ore reserves. The ore also contains some lead and silver.

The Kashmir zinc deposits yet remain to be systematically investigated. The ore is known to be rich but the reserves are unknown.

**Suggestions for future Development.**

Realising that a large quantity of zinc is consumed every year in India we cannot afford to reconcile ourselves to importing all our requirements of zinc. It is necessary to maintain even a small smelter in India to meet at least some of the defence requirements. We sugget that Government should take immediate steps to investigate the Zawar and Kashmir zinc deposits and to start a smelter. As mentioned in the section on lead the Burma lead-zinc ore could be imported and smelted in India and we repeat that negotiations should be undertaken with the Burma Government to that end. Several attempts were made in the past to smelt the Burma zinc concentrates in Bihar. These projects should be renewed if sufficient ore is available. Naturally any zinc smelting industry will need protection in the nature of subsidies. We suggest that imports of zinc should be duty free and all the semi-manufactures and zinc compounds like zinc chloride, zinc oxide, etc., required for use in India should be indigenously produced. Zinc strip for dry cells and zinc process plates could also be manufactured in India.

## TIN

**Uses.**

Owing to its good resistance to corrosion under many conditions the major use of tin is in the form of coatings for steel and copper alloys. Nearly 40 per cent of world's tin is used in making tin plate. Solders come next in importance. Other alloys containing tin are white bearing metals, pewter, type metals and bronzes. In the pure form tin is used for manufacture of tin piping for beer, distilled water, etc., as collapsible tubes and as foil. There are also a large number of chemical uses of tin.

## International Controls.

In 1930 the tin producer's Association inaugrated a voluntary restriction scheme over the production of tin, but by the end of the year it was realised that any voluntary control was powerless to cope with the situation in the form of declining consumption, falling prices, etc. In 1931 a government sponsored restriction scheme under the administration of an International Tin Committee went into effect. The Committee represented the Governments of the chief tin producers, viz., Federated Malaya States, Nigeria (British), the Dutch East Indies and Bolivia. Later on excepting China all the tin producing countries were represented on the Committee. This virtual control of world's production has been manifested in the high prices of tin.

## Indian Imports and Consumption.

Indian imports of tin in the form of ingots, bars, slabs, foil, etc., amounted to about 8,000 tons per year. Besides this tin is imported in the anti-friction alloys and as parts of the machinery, etc. Due to this invisible import of tin the total consumption of tin is rather difficult to assess but we consider that about 4,000 tons per year of tin will be consumed in India during the first five post-war years. This includes tin in all forms.

## Indian Tin Ores.

Several localities are known in India where tin stone (Cessiterite) has been found in small quantities. The most interesting of these areas is that in the Hazaribag District. None of these ores are said to be very promising.

Some East African or Malayan tin ore was smelted in India during this war as an emergency measure. Smelting of tin presents little difficulty and if enough imported ores are available tin smelting should be encouraged.

## Secondary Tin Industry.

Recovery of tin from tin-plate scrap is an important industry in countries like Japan, U. S. A. and Germany. During the war several Indian firms took up de-tinning of tin plate scrap and their total capacity is about 100 tons of tin per year. The cost of de-tinning is, however, high and the main cause for this is attributable to expensive and mixed scrap and lack of continuity in the availablity of scrap. These conditions are not likely to change immediately and assistance to this industry is considered necessary.

## Suggestion for Tin Industry.

During the war the Allies had lost the major sources of tin which prompted them to economise in the use of tin and in most cases substitute other metals for tin. Since no tin is indigenously produced we suggest that every effort should be made to cut down the use of tin and use of substitute alloys. Numerous small tin refineries existed before the war in Holland, Belgium, Germany and France refining impure tin. Impure tin is obtainable much cheaper than standard tin tingots and the existence of such a refinery in India would reduce the import of tin and in case of an emergency make the country independent of tin imports at least for a few years. For the development of a tin industry in India we recommend :—

(1) Prospecting for tin ores in India.

(2) Importing tin ores or concentrates, either from China, Malaya or Africa and smelting them in India.

(3) Development of spraying and electro-tinning for making tin plate in place of the existing hot dip process.

(4) Encouraging de-tinning and assisting the existing firms to enable them to compete with imported tin which should be duty free.

(5) Encouraging Electrolytic tin refining of impure tin or tin-rich scrap collected in India or imported from abroad.

(6) Prohibiting export of tin plate scrap and allowing duty free imports of same.

## NICKEL

### Uses.

The largest use of nickel (about 60 per cent of world's production), is as an alloying element in steel. It is also used in many non-ferrous alloys such as nickel-silver, copper-nickel coinage alloys, monel metal, nickel-chromium heat resisting alloys, etc. In the unalloyed form nickel is used for coinage and cooking utensils and as anodes in nickel plating. The metal is also used by the chemical and paint industries for vessels and plants of various kinds on account of its corrosion resistance.

### International Controls

The nickel industry offers the outstanding example of monopolistic control over an important primary commodity by a world combine. Nature has centralised the usable nickel ores in the Sudbury region of Ontario, Canada. These and other deposits are controlled by the International Nickel Company whose sales amount to over 95 per cent of the world's nickel business. The monopoly power of the Company established by an amalgamation of several Companies is firmly based on property holdings in Sudbury. The United States of America, United Kingdom and Canada are represented in the Company with the U. S. having 43 per cent of the stock.

### Indian Requirements.

Nickel is imported in many forms in India but the tonnage in the form of nickel is difficult to ascertain. We consider that the peak annual consumption of nickel in all forms will be about 3,000 tons during the first five post-war years. All this will have to be met by imports unless steps are taken to produce nickel in India.

### Indian Nickel Ores.

Besides occurring as a minute constitutent of some copper ores in Singhbum and in the Khetri mines of Jaipur nickel is unknown in Indian deposits of appreciable size. However a self fluxing nickel ore has recently been reported to exist in the snow bound regions of the Himalayas, north of Nepal.

Cobaltiferous nickel speiss has been produced since 1927 by the Burma Corporation's Badwin mines as a by-product of the lead smelting plant at Namtu, amounting to some 3,000 to 4,000 tons yearly. Before the war this was exported to Belgium and Germany for refining.

### Suggestions for Nickel Industry.

Two sources of ore for starting a nickel industry in India suggest themselves. The Nepal ores are reported to be rich and contain both cobalt and silver besides nickel. It should be possible to survey these deposits extensively and either smelt the ores in Nepal or somewhere in British India. Transportation of ore will be a big problem but modern ingenuity should be able to cope with any of these problems. The second and immediate possibility is importing Burma complex sulphide ores for treatment into India. The treatment and refining of these and other sulphide ores need to be encouraged as it would not only supply Indian demands for the metal but also sulphur which could be recovered as a by-product. If for some reason it becomes impossible to import the ores or concentrates at least the nickel speiss which used to go to Belgium and Germany should be imported for treatment in India.

About 2,000 tons per year of nickel silver is also imported into India. If the demands for this commodity justify a rolling mill for rolling nickel silver sheets we suggest that such a proposition should be encouraged.

In conformity with our general policy we suggest that both virgin nickel and ores or concentrates should be imported duty free.

## MAGNESIUM.

### Uses.

The metal is important for its lightness, being lighter than aluminium. Magnesium wire and ribbon are used in radio industry for degassing valves. In copper, brass and nickel alloys it is used as a deoxidiser. Its properties are considerably improved by alloying with aluminium and zinc (Elektron Alloys). Magnesium is also an essential constituent of certain aluminium and zinc alloys.

Magnesium alloys are extensively employed in the aircraft field, both in cast and wrought forms, for engine parts such as crank cases, landing wheels and under-carriage members, forged air screws, petrol and oil tank, interior fitting, etc. Road transport has also made extensive use of magnesium alloys for gear and crank cases, pump parts and covers for various purposes. They are also used in machines where low inertia is particularly valuable, *e. g.*, machine tools, printing and textile machinery, electric motor castings and air conditioning plants. The use of magnesium in pyrotechnics and incendiary bombs in war time is very considerable.

For lack of other metals Germany has been using magnesium alloys for telephone switch parts, optical instruments, microscopes, busbars, etc.

**Indian Consumption.**

Before the war Indian consumption of magnesium was very little. During the war it was mainly used by the aircraft industry though the exact tonnage is not known.

**Indian Magnesium Ores.**

India possesses immense reserves of magnesite (Magnesium carbonate) in the "Chalk Hills" of Salem, Madras, and in the vicinity of Mysore City. The Salem magnesite deposits are of exceptional purity, being composed of over 97 per cent magnesium carbonate and the quantity available from them, according to the present annual rate of extraction is almost inexhaustible. The reserves are calculated at several thousand million tons. The Mysore magnesite deposits are also of high degree of purity and the reserves are calculated to be over a million tons. Both these deposits are worked by open cast method and are capable of considerable expansion of output without resorting to expensive mining operation. About 43,000 tons of magnesite was mined in India during 1939. At present some magnesite is used for making refractories and special cements. However, most of the magnesite mined is exported. No difficulty is expected in obtaining supplies of pure magnesite in India. The largest and an inexhaustible source of magnesium however is sea water from which magnesium is successfully recovered in the United States of America.

**Suggestions for Magnesium, Industry in India.**

Magnesium is one of the important light metals, and in any future planning its development cannot be over emphasised. The uses of magnesium are manifold and India is so placed with regard to non-ferrous metal ores that unless light metal industries like aluminium and magnesium are fully developed, she will have to depend to a large extent on imported metals. Germany for lack of other metals has developed her magnesium industry to such an extent that magnesium is sometimes called "German metal".

We attach a great importance to starting a mangnesium industry in India and if private entereprise because of economic reasons is shy, the Government should take up its production. In very few countries has the production of magnesium been an economic proposition but the exigencies of war or demands of national self-sufficiency have prompted Governments to assist this industry and bring it to a stage where its production becomes economic.

Two schemes for production of magnesium metal have been brought to our notice—one to be started at Kharaghoda on the outskirts of the Runn of Cutch and another for treating the magnesite of Salem. We suggest that Government should examine these schemes in detail and assist in making them practicable.

At Kharghoda salt works it is proposed to manufacture magnesium from the magnesium chloride manufactured from the Bitterns after the removal of salt by the Bombay Salt Department. The brine available is highly concentrated and the preliminary difficulties of producing magnesium chloride from sea water as are encountered in the U. S. A. could be avoided. However, power is not available at Kharaghoda and possibilities of providing cheap power for magnesium reduction needs investigation.

The Salem magnesite is proposed to be treated by Pidgeon process.

Since we do not anticipate a large consumption of magnesium in India in the immediate future, we recommend that a secondary magnesium industry, recovering magnesium by distillation from magnesium rich aircraft scrap, should be started to develop a magnesium market in India. A considerable quantity of such scrap is available in India and can also be imported cheaply from abroad. Production of virgin metal could be taken in hand during the second five-year period.

## MANGANESE.

### Uses.

The metal itself has no application at present, but its alloys are extensively used. Alloys made from fire-refined (98 to 99 per cent) manganese give different properties from those made out of electrolytic pure manganese. The latter are superior in all respects.

Manganese is used as an alloying element in special brasses and aluminium alloys. Alloys of iron and manganese are extensively used in the manufacture of steel, where they are used both as deoxidisers and alloying elements. About 95 per cent of world's manganese production is used directly or indirectly in the production of steel, usually in the form of spiegeleisen (5 to 20 per cent manganese) or ferro-manganese (25 to 80 per cent manganese). The production of ferro-mangenese is not much different from the production of pig iron in blast furnaces.

Of late years interest has centred round the production of high purity manganese metal and intensive research for this purpose is in progress in western countries. High purity manganese is considered to have a potential use in making valuable alloys and both in the United States and Canada patents of interesting manganese alloys using high purity manganese of electrolytic origin have been taken out. These alloys have high modulus of elasticity, high electrical resistance and remarkable vibration damping capacity.

**Indian Manganese Ores.**

The reserves of manganese ores in this country are of large dimensions. The principal deposits are capable of surface open cut methods of mining, depth mining being unnecessary. India is one of the two principal producers of high grade manganese ores in the world. Over 95 per cent of the output however is exported. Since 1900 India has exported over 30 million tons of high grade ores. Only an insignificant proportion of the quantity mined was, up till lately, smelted in the country for the production of ferro-manganese and in the various chemical industries such as those connected with the manufacture of dry cells batteries, pigments, and in glass and ceramic industries as glazes and enamels. Since the War, about 20,000 tons of ferro-manganese is being manufactured annually.

The chief ores of manganese are the oxides, pyrolusite and psilomelane. They are widely distributed in the ancient crystalline rocks of Deccan, occurring as large surface deposits in Singhbum; Eastern States Agency; Balaghat, Bhandara and Nagpur districts of Central Provinces ; Bellary, Vizagapatam and Sandul districts of Madras, Panchmahals of Bombay and several other districts of Bombay and Mysore. The mining of manganese is comparatively inexpensive by open cast methods of surface extraction in all these districts, hence the price of first-class ore has fluctuated between 15 to 40 rupees per ton f.o.b. There is no difficulty as regards the quality, quantity and availability of ores of various specifications of this metal in India.

In manganese ores required for chemical and electrochemical industries, as oxidising agents, the manganese content is not so important as the percentage of liberated oxygen. For such purposes, the ore should normally contain 84 per cent of manganese dioxide but 72 per cent manganese dioxide is permissible in certain cases. The ore mined from the Keonjhan State of the Eastern States Agency and some parts of Singhbum is suitable for use in chemicals and dry cell batteries.

**Suggestions for Manganese Industry.**

The metals Committee of the Board of Scientific and Industrial Research have been investigating the question of making electrolytic manganese in India. The question is of great importance and needs to be pursued facture of manganese we feel that the State should take up its manufacture. However, we suggest that the State should give every help and guidance to any firm who wants to enter the field before taking up its manufacture as a state owned enterprise. We understand that a reputed firm in Bombay intends to put up a pilot plant to produce 1000 lbs. of high purity electro-manganese per month. We recommend that the Government should give facilities for the import of electrical and other equipment needed for this plant and also give them other help they may need in starting a very important industry.

As regards exports of manganese ores we feel that large exports of minerals of any kind are detrimental to the best interests of the country. In the case of Indian minerals huge profits have been made abroad by foreign interests, which should have come to India in the natural course. We expect that India will need and should therefore produce increasing amounts of ferro-manganese. Also most of the manganese exported is converted into ferro-manganese by the importing countries and we strongly recommend that Government should encourage the export of ferro-manganese rather than manganese ores. This will not only give employment to Indian labour but will also give an impetus to Indian industry.

## ANTIMONY

**Uses.**

"Crude" or Antimony sulfide, i.e. ore containing about 90% Stibnite is itself marketable, being used in vulcanizing rubber, in match making and in ammunition manufacture. The pure metal has practically no commercial application. However it is largely used for the manufacture of alloys. Important alloys are copper-tin-antimony, used for bearing metals; Britannia metal, which is mainly tin and antimony and type metal which contains lead-tin and antimony.

Antimonial lead is extensively used in the production of shrapnel bullets, and another similar alloys find use in the manufacture of battery plates, toys, syphon-top and cables. Antimony upto 2 percent is also a constituent of some solders.

**Indian Antimony Ores.**

The principal ore (stibnite) occurs in small deposit at the Shigree Glacier in Lahaul (Kangra District, Punjab) and at Shagor in Chitral. Both are highly inaccessible localities requiring man-handled transport over high passes and a long journey before reaching the rail head at Pathankot or Peshawar. A certain quantity of stibnite is being worked from Chitral to-day from several distinct deposits. The Lahaul deposits though believed to be much larger, have not been worked owing to transport difficulties.

**Antimony Smelting in India.**

Due to exigencies of war antimony ores though of poorer quality than in other parts of the world began to be mined at Chitral and are at present smelted in Bombay. The mines are inaccessible in winter months and the ore has to be carried by mule and man over mountain passes which makes the cost of transport excessive. The smelter at Bombay can produce 300 tons of antimony per year. No direct Government assistance is given to the industry at present but it is sustained due to the high prices prevailing in the market. With the stabilisation of general prices the cost of production may come down. The firm is also trying to make better arrangements for concentration and transport of ore which may bring down costs. We are confident that all the post-war requirements of antimony which may reach about 400 tons per year during the first five years could be met by indigenous production. This is one case in which we do not recommend the import of metal duty free, because antimony is used not in large tonnages but in small amounts as an alloying element, and duty free antimony would put the existing industry out of business. We recommend that the ruling price of antimony should be on parity with the imported cost plus 25% import duty and the smelter in India should sell their products at this price. Difference between this selling price and the cost of production in India should be met by a subsidy. Since the indigenous production can meet the requirements of the country imports from abroad should be controlled. We recommend that only the existing smelting firm should import, with the approval of the Government of India, the deficit quantity, if any, over the indigenous production.

## BERYLLIUM.

**Uses.**

As pure metal, Beryllium is used for windows in X-ray tubes and as a coating to steel to prevent attack from hydrogen at high temperatures. Its most important commercial use is as an alloying metal with copper, nickel, cobalt and iron. Heat treated copper-berryllium alloy(2.25 percent beryllium) gives a strength about six times that of soft copper without too much reduction of electrical conductivity. It is thus suitable to replace phosphor-bronze current carrying springs in electrical apparatus where it can be stressed 50 per cent higher without taking a permanent set. Beryllium copper also finds use in wear resisting parts as bushings, cams, sleeves, rollers, etc., and in the manufacture of tools because of its non-sparking properties. Nickel-beryllium alloys have remarkable physical properties and can be used for springs, heavily stressed structural members, etc. Iron-nickel-beryllium and iron-chromium-nickel-beryllium alloys have high corrosion and heat resistance.

**Indian Beryl.**

The mineral beryl is the chief source of the metal. Percentage of beryllium in beryl varies within wide limits from 3 to 14 per cent. In the beryl obtained from several Indian localities it is generally 12 to 14 per cent and therefore Indian beryl is of considerable value.

Important sources of beryl in India are the mica-pegmatites of Bihar, Nellore, Ajmer-Merwara and Udaipur. Rajputana produces some excellent beryl for export, between 1932-35 it shipped between 100 to 300 tons of beryl annually analysing 12.5 to 13.5 per cent beryllium, oxide. Exact estimates of probable reserves are not available, but a steady supply of the order of 100 to 150 tons can be expected from the above localities, so long as mica mining remains remunerative. It is probable that prospecting in the crystalline areas of Bihar, Rajputana and Madras may reveal important sources of beryl. The possibilities of increasing the present output depends entirely on the demand for this mineral for manufacture of the highly speciliased copper and nickel alloys in India.

**Suggestions for Beryllium Industry.**

So far, the valuable mineral beryl mined in India has been exported at a ridiculously low price of about Rs. 150/—per ton. Modern metallurgical research has proved that small quantities of beryllium can be advantageously used in copper, nickel and other alloys. In Europe and America beryllium industries have been started around beryl imported from India.

We feel that our beryl deposits are important national assets and strongly recommend that export of beryl should be altogether banned. The metals Committee of the Board of Scientific and Industrial Research has been carrying on some investigations for making beryllium copper alloys in India. Their progress up-to-date is not known but we feel that these investigations should be systematically pursued and beryllium and its alloys should be made in India. If commercial production is uneconomic we propose that the Government should take up its production as a State-owned enterprise and encourage the use of beryllium alloys.

## ARSENIC.

**Uses.**

Metallic arsenic does not have many commercial uses. As an alloying element small amounts of arsenic are useful in copper which is to be subjected to reducing conditions at high temperatures. It is used up to 2 per cent in lead for making shots and sometimes substituted for tin in lead base bearings. In small quantities it is also beneficial in brass.

In the form of compounds there is a market for red and yellow sulphides of arsenic. The most important use of arsenic, however, is as the white oxide which is widely used for making insecticides like weed killers and cattle dips. Arsenic oxide is also used as pigment, as component of enamels and as a decolorizer in glass manufacture.

**Indian Arsenic Ores.**

The two important ores of arsenic are the sulphides-orpiment and realgar. These occur at six distinct localities in the Chitral State at elevations of 11,000 to 16,000 feet. New deposits are likely to be found capable of supplying the whole quantity required for Indian consumption. Before the war the extraction of arsenic compounds from Chitral was insufficient and India imported about 150. tons per year of arsenic oxides. Recently a valuable deposit of mispickel has been located at Sampthar in the Kalimpong area in Darjeeling district. Some samples have analysed upto 27 per cent arsenic.

**Suggestions for Arsenic Industry.**

There are enough ore deposits of arsenic to start an industry to meet all the Indian demands both as metal and as compounds. We suggest that the possibilities of treating these ores should be investigated. We also recommend that nickel speiss, produced at Namtu in Burma, which contains about 40 per cent arsenic besides nickel and cobalt should be imported for treatment into India. This alone would meet most of arsenic requirements of India, including the amounts required for making arsenical copper.

## BARIUM.

**Uses.**

Barium is used for ignition equipment in automobile industry in which it is used as a high nickel alloy. In the radio industry it is used to clean up last traces of gas in vacuum tubes. The tenary alloys of lead with both calcium and barium are used as bearing metals. Excellent results are claimed for bearing purposes for these alloys. The thermionic emission from filament coated with barium is appreciably increased by using an alloy of nickel and small quantities of barium as the base metal instead of pure nickel. Barium compounds find a great use in ceramic and glass industries. Barium sulphate is largely used for preparation of paints and for increasing the density of drilling muds when boring for petroleum.

**Indian Barium Ores.**

Barytes—the chief ore of barium—occurs in large deposits in the Cuddapah and Ceded Districts of Madras. The mining of these deposits presents no difficulties. Alwar in Rajputana and Jubbulpore in Central Provinces also have deposits of barytes. The total Indian production of barytes in 1941 was 22,250 tons, which was chiefly used in the paint industry.

It is possible to make some barium alloys in India and we suggest that the possibilities of making such alloys should be looked into.

## TITANIUM.

### Uses.

The uses of titanium as pure metal are limited but it finds considerable use as an alloying element with steel, copper and aluminium. It is added not only as a grain refiner and scavanger but also for imparting useful properties. The major uses of titanium mineral are in pigment, dyeing and ceramic industries and in the manufacture of welding rods. As titanium carbide it finds uses in making hard metal carbides along with tungsten and tantalum carbides for making cutting tools.

### Indian Titanium Ores.

In India there are vast deposits of titaniferrous magnetite in Singhbum and Mayurbhanj districts. The chief titanium mineral ilmenite is found in the Rajputana States. The bauxite deposits of India now worked for the manufacture of aluminium contain appreciable quantities of titanium which can be recovered as a by-product. The beach sands of Travancore contain titanium along with other minerals.

### Suggestions for Titanium Industry.

The export of Travancore sands during recent years has been increasing to an extent where it is feared that the easily workable sands will be exhausted in a couple of decades. We strongly recommend that exports should be curtailed or stopped altogether in order to save this mineral for Indian use. We also feel that the production of Standard titanium alloys for use in aluminium and brass industry should be undertaken in India. The Metals Committee of the Board of Scientific and Industrial Research has been tackling the problem of manufacturing these alloys. We feel that their manufacture is commercially possible to the extent of developing an export market for these alloys. The industry however will need help both financial and technical in the early stages of development.

Production of ferro-titanium is also feasible. We trust that the Iron and Steel Industries Panel will examine the problem.

## CHROMIUM.

### Uses.

As pure metal chromium is used as a plating on both ferrous and non-ferrous alloys because of its pleasing appearance and high corrosion resistance. Alloys of chromium are notable for high resistance to heat and electricity, high tensile strength and corrosion resistance at high temperatures and also resistance to attack by acids and alkalies. Nickel-Chromium alloys have valuable heat resisting properties and are used as heating elements in electric furnaces. Chromium alloys are also used as thermocouples for temperature measurements. The most important use of chromium however is as an alloying element in steels where it is used up to 20 per cent. These steels are used for armour plates, projectiles and high speed tools, dies, etc. Chromium is added to steel in the form of ferro-chrome.

The mineral chromite is used in the manufacture of dichromates, chromic acid and various chromium salts used in a variety of chemical industries. Chromite refractories find use in steel making furnaces.

**Indian Chromiun Ores.**

Chromite—the chief ore of chromium—is found in Zhob Valley (Baluchistan), Mysore, Sandur, Sarai-Kela State, Ratnagiri and other places. The deposits are said to be large and have been mined at several places. During war years the production was about 50,000 tons per year out of which about 12,000 tons were used in India and the rest exported. Before the war almost the entire output was exported.

**Indian Chromium Industry.**

The production of ferro-chrome and chromium compound, we trust, will be dealt with by other Panels. We feel however that it should be possible to make nickel-chromium and other chromium alloys in India. With India's industrial development there will be more demands for electric heating elements, thermocouples, etc. and we suggest that the possibilities of processing these alloys in India should be investigated.

## TUNGSTEN

**Uses.**

Tungsten is used as an anti-cathode in X-ray tubes, as a filament in electric light bulbs, for magnets and other contract materials, etc. In the form of cemented tungsten carbides it has made great strides in the production of tool tips giving a better cutting edge than high-speed tool steels. A very hard bronze consists of an alloy of copper with 2 per cent tungsten, and 3 per cent tin. An electrode containing 98 per cent tungsten, 1.5 per cent titanium and 0.5 per cent chromium is used as a source of ultra violet radiation.

**Indian Tungsten Ores and their development.**

Wolfrom, the chief ore of tungsten is found in workable amounts but on a small scale at Degana in Rajputana, and on a still smaller scale at Kalimati, Singhbum and at Nagpur. Estimates of reserves at the above localities are not made. However, when compared to the known deposits of Tavoy in Burma these deposits look very small. The present consumption of tungsten in India is not appreciable but there is likely to be considerable demands with the future expansion of steel industry.

We suggest that extensive prospecting for tungsten should be taken in hand and also the possibilities of importing ores from Burma and China should be investigated. If not in the immediate future at least within ten years from now the demands for tungsten not only as a ferro-alloy but also as filament, anti-cathodes, tungsten carbides, etc. is bound to increase sufficiently to maintain a tungsten industry in India.

## OTHER METALS.

So far the metals we have dealt with are of more or less industrial importance as metals or alloys. We feel that it will not serve any useful purpose to consider in details metals like bismuth, cadmium, calcium, cobalt, mercury, molybdenum, silicon, strontium, vanadium and zirconium, which at present are of minor industrial importance from the view point of non-ferrous metal industries development. They are however briefly discussed in the following paragraphs.

Ores of bismuth, cadmium, mercury and molybdenum are rather rare in India.

Cobalt ores of some importance are found in Nepal. Cobalt is also found in association with copper pyrites at Khetri. However if the nickel speiss produced at Burma which also contains cobalt, is imported into India it will not be immediately necessary to develop the inaccessible cobalt ores of Nepal.

There is no dearth of calcium and silicon minerals in India and the production of calcium and silicon can be taken up when demands justify their production. At present their use as metals is rather limited.

Deposits of celestite (Strontium-sulphide) of some importance have been found in the Trichinopoly district. The mineral is practically free from impurities and the deposits are easily workable. Indian demands for strontium salts are of the order of a few tons only. However the local demand can easily be met by the treatment of Trichinopoly ores.

Vanadiferous iron ores are found in large quantity in Mayurbhanj and in Singhbum. These ores contain metallurgically usable quantities of vanadium, and their treatment for the production of ferro-vanadium, for use in the steel industry should be encouraged.

Large quantities of Zircon are obtained from the ilmenite sands of Travancore beach in which it occurs to the extent of 6 or more per cent. The unrestricted exports of both minerals need to be checked at an early date. There is a good scope for large-scale manufacture of zirconium refractories in India, especially for export. An extensive outlet for zircon has lately been established in the U. S. A. using finely ground Zircon for facing sand-moulds for Steel and bronze castings. It is claimed that the Zircon facing prevents the metal from penetrating into the sand moulds, thus giving very smooth surfaced castings.

## NON-FERROUS REFINING INDUSTRIES.

In every industrial country refining of scrap has been done on a large scale. Large quantities of non-ferrous scrap arise in India every year and the recovery of metals from this source needs to be substantially encouraged. Before the war most of the Indian scrap was exported to Japan, Germany and other countries, at very low prices and reimported in the form of refined metals. Since very few virgin metals and those too in small tonnages are produced in India we feel that this important source of secondary metals—which are as good as virgin metals after refining—should be fully utilised in India and we strongly recommend that exports of all non-ferrous metals scrap should be altogether banned.

The utilisation of yellow metal scrap (alloys of copper with zinc and tin) has been carried out in India since ancient times. Large quantities of debased scrap of unknown quality are even today consumed in the making of domestic utensils, trinckets, etc. It is feared that such unsegregated mixed scrap would not be readily used for making alloys for engineering purposes and we suggest that the secondary metals industry should be organised with a view to the collection of clean scrap. Mixed scrap of unknown origin increases the cost of refining. We feel that an Association of scrap Dealers should be formed who would take upon themselves the duties of collecting and segregating scrap of all kinds besides the function of marketing the same. In this respect the most modern practices used in U. K., U. S. A. and Germany should be adopted.

There are several firms, now engaged in refining scrap, who refine both yellow and white metal (alloys of tin, lead, antimony) scrap and produce gun metal ingots, phosphor-bronze, type metals, bearing metals, etc. This industry has been a great help to India during the war and it is believed that they will be able to hold their own against post-war foreign competition provided an adequate quantity of clean scrap is made available to them. The problems of secondary metals are further dealt with in Appendix VI.

A scheme for the production of electrolytic copper from copper and brass scrap has been brought to our notice. We feel that in the absence of any indigenous production of electrolytic copper the promoters of this scheme should be given adequate assistance and encouragement.

Another important secondary metal industry is the detinning industry. We have dealt with it in the section on tin and repeat that a large-scale de-tinning industry is necessary for India and Government assistant to this industry should be continued. It is also possible to electrolytically refine impure tin and such an industry should be encourged in India.

## POWDER METALLURGY.

Powder Metallurgy is the art and science of making metallic articles by pressing and sintering of metal powders. Small intricate shapes which cannot be easily cast or machined are so produced. Also articles of refractory metals like tungsten, molybdenum, etc., which cannot be melted easily can be made by powder metallurgy methods. Almost all metals can be powdered and articles made by powder metallurgy methods are not only considered to be equal in properties but sometimes lower in cost than those produced by the conventional methods of casting and machining. Important examples of articles so made are oilless bearings, tungsten carbide cutting tips, electrical contact materials, parts of small apparatus, etc.

In recent years great strides have been made in England and America in the technique of Powder Metallurgy and we feel that India can profitably use this branch of metallurgy. Demands for powder metallurgy products will certainly be felt in India with increased industrial development. We suggest that the possibilities of starting a powder metallurgy industry in the near future should be thoroughly explored.

## REQUIREMENTS OF CAPITAL GOODS

Without any definite knowledge of the ore reserves and methods of treating them it will not be possible to draw up a list of capital goods requirements for the smelting of copper, zinc, lead and other metals. However, in view of the fact that the semi-manufacturing industry has been well established during the war and is expected to meet all the indigenous demands for sheets, foils, wires, tubes, rods etc. a list of new plant and machinery for this industry, prepared by Mr. A. D. Wilks of the Metals Directorate of the D. G. M. P., is given in appendix VII. Cost of plant and equipment needed for producing electrolytic copper out of copper and copper alloy scrap is also given in the same appendix.

We feel that before importing new equipment all possible steps should be taken to make available to the industry the surplus equipment of the ordnance factories. Attempts should also be made to obtain surplus lend-lease equipment and also the surplus equipment available in the United States of America and the United Kingdom. India should also have its proper share of the plant and machinery obtainable from Germany, Japan and other enemy countries. In this connection it will be necessary to send a deputation to these countries to inquire and obtain the equipment that can be used in India.

Items of equipment which could be immediately manufactured in India are indicated in the appendix. It is however quite possible to manufacture several other items if proper facilities are made available. In view of the present difficulties in importing capital goods we recommend that efforts should be made to produce most of the heavy machinery in India.

## INFORMATION ON NON-FERROUS METALS

For the systematic and scientific development of non-ferrous metal industries it will be necessary to launch an educational and information programme. There is an urgent need for a popular journal which would give information on various aspects of making, shaping, and treating of metals and alloys. It is the general expectation that aluminium and magnesium will be the metals of the future. In order to popularise these metals and instruct workers in the handling of these metals a journal dealing entirely with light metals should be published. Trade information, price fluctuations, stock positions of metals and almost all the relevant information of interest to the non-ferrous metal manufacturers and consumers should be included in these journals. The existing industrial associations should undertake such an information programme. It is also necessary that the Indian Railways should have Central Research Organisation to meet the different non-ferrous metal problems that may arise from time to time due to the impending increased and varied nature of activities on the Railways with the execution of their different post-war plans.

In most of the western countries research laboratories are maintained by groups of interested firms. This practice can also be followed in India since there is a pressing need for research work on almost all aspects of the non-ferrous metal industry.

## CHAPTER III

## SUMMARY

In this Chapter the relevant information about uses, international controls, consumption, production, etc., of the industrial non-ferrous metals is given. Occurrences of ore deposits, recommendations about their development and the protection to be given both to virgin metal producers and semi-manufacturers of sheets, rods, bars, wires etc., is indicated for each metal. We anticipate that India will consume increasing quantities of non-ferrous metals in the coming years with the general advance of industrialisation. From the information available to us we estimate that consumption will be about as follows :—

| Metal | Estimated Annual Peak consumption during the first five-year period in long tons. | Present annual production in long tons. | Annual production Targets to be aimed at during the first five-year period in long tons. |
|---|---|---|---|
| Copper for copper base alloys. | 25,000 to 30,000 | 6,000 | 8,000 to 12,000 |
| Electroytic copper | 16,000 to 20,000 | Nil | 10,000 (from scrap refining). |

| Metal | Estimated Annual Peak consumption during the first five-year period fn long tons. | Present annual production in long tons. | Annual production Targets to be aimed at during the first five-year period in long tons. |
|---|---|---|---|
| Copper and Brass sheets. | 35,000 to 40,000 | 10,000 (specification sheets)<br>15,000 (non-specification sheets). | 6,000 copper sheets.<br>35,000 Brass sheets. |
| Copper and Brass wires, Cables, rods tubes etc. | Not estimated. | Not estimated. | All Indian Requirements. |
| Lead | 25,000 | 100 | 10,000 to 12,000 (from new Indian mines). |
| Zinc | 50,000 | Nil | Depending upon availability of imported or local ores. |
| Tin | 4,000 | Nil | do |
| Tin from detinning | | 30 to 40 | As much as possible. |
| Aluminium ingots | 20,000 to 25,000 | 2,400 | 15,000 minimum |
| Aluminium Sheets | 10,000 to 12,000 | 1,500 (specification)<br>8,500 (non-specification). | 10,000 (specification) |
| " Foil | 1,500 to 2,000 | Nil | 1,500 to 2,000 |
| " Wires & Cables | 5,000 and up | Nil | 5,000 and up |
| " Powder | 1,000 | 100 | 1,000 |
| " Tubes & shapes | 2,000 | Nil | 2,000 |
| Antimony | 400 | 200 | 350 to 400 |

The above consumption figures include not only the use of the metals in the unalloyed and alloyed form but also as powders, pigments and such chemical compounds as are made from them for industrial uses. It is impossible to estimate with any greater accuracy the probable consumption during the next five-year period as this can only be calculated after the needs of the consuming industries are known. The production targets we have recommended are not high and could be easily achieved with proper co-operation between the various Governmental agencies and industrialists. In cases where raw materials for the production of these metals are not available within the borders of India we have recommended duty-free imports of such raw materials by negotiations with Governments of other countries. In our opinion India should make full use of the vast deposits of aluminium, Magnesium, Manganese, Titanium, Chromium, Beryllium and other ores available in the country. By producing and using large quantities of these metals and their alloys and substituting them for metals not easily available from indigenous sources it should be possible for India to be independent of outside sources for her supply of non-ferrous metals. This naturally means intensive investigations, encouragement and protection to the industries by the State as also some sacrifice on the part of the consumers.

With regard to Government protection and help to be given to indigenous producers of virgin metals we feel that the amount of protection will depend on individual cases. Metals and alloys are consumed in fabricated forms and the interests of semi-manufacturers and fabricators are also to be protected along with those of the producers of virgin metals. It is our contention that all the Indian requirements of semi-manufactures such as sheets, rods, tubes, wires, etc. could and should be produced indigenously. Since Indian producers of virgin metals are not yet in a position to supply all the demands of the semi-manufacturers, import will constitute a major part of India's non-ferrous trade. In our opinion virgin metals and scrap needed for semi-manufacturing industry should be imported duty free, while duty on imported semi-manufactures should be high. To give an instance the present revenue tariff of 30%. on all aluminium sheet and circles is a handicap, particularly as fabricated articles can be imported under other classifications at much lower tariffs. Thus aluminium dairy equipment can be imported free of duty even though such equipment is manufactured in India. Another case is aluminium fittings for railway rolling stock, where the tariff rate is only 10%. We recommend that all such discrepancies should be immediately corrected.

Protection to virgin metal producers will have to be in the nature of bounties or subvention. It has been brought to our knowledge however, that one of the reason for the high production costs of virgin metals are high railway freight rates. To give one example it is necessary to move seven tons of raw materials to produce one ton of aluminium, and even though electric power were available as cheap as in Canada the indigenous producers would not be able to bring down their costs materially because of the high freight rates.

Another important point we note is that in India the railway freight on minerals transported to ports for export purposes is much less than the freight on minerals which are being moved from the mines to the smelters. Naturally no Indian smelter would expect to bring down its costs under these circumstances and it is our considered opinion that if freight rates are adequately reduced not only will the amount of subsidy to be given to primary metal producers will be less but in due time the industry will be able to stand on its own legs and develop an export market. Other reasons for the high production costs of virgin metals are high cost of power, smaller units, low efficiency of units and lack of technical skill.

It is possible to produce a reasonable tonnage of copper, zinc and lead in India if intensive prospecting and development work is immediately undertaken. We feel that there is a vast scope for the development of aluminium in India and the Railways and other Government departments must take the lead in replacing other metals with aluminium. Aluminium cables should be immediately manufactured in India to meet the requirements of new power development projects. India's resources of bauxite are so vast that it should be possible to develop an export market for aluminium and its products.

We feel that Indian demands for Magnesium metal during the first five-year period would not be large enough to justify importing and erecting expensive plants for its manufacture. A market for magnesium could be developed by marketing secondary magnesium recovered from aircraft magnesium alloy scrap and actual erection of a plant manufacturing virgin magnesium could be deferred to the second five-year period. A pilot plant should however be operated by the Government.

We strongly recommend that the nickel speiss which was exported to Belgium and Germany from Burma should be imported and treated in India for the recovery of nickel, cobalt and arsenic.

The production of high purity manganese, beryllium alloys and titanium master alloys could be undertaken within the first five-year period.

Careful attention should be paid to secondary metal industry and refining of scrap metals from indigenous and imported scrap should be encouraged. It is possible to put up plants for electrolytic refining of copper and tin scrap and Government should give every assistance to promoters of such schemes. De-tinning of tin plate scrap undertaken during war time should be further encouraged.

We are of the opinion that as major non-ferrous metals begin to be developed demands for minor non-ferrous metals will increase. India possesses sufficient ore reserves of such minor metals as barium, tungsten, tantalum, calcium, silicon, strontium, vanadium, Zircon and rare earth metals which could be developed with the progress of industrialisation.

A list of capital goods requirements for the immediate use of semi-manufacturers is given in appendix VII. If Government can make available to the industry the surplus equipment of Indian ordnance factories it will ease the situation because of the difficulties connected with imports of capital goods. Most of the items which we at present think will need to be imported could be manufactured in India by proper planning and co-ordination of the various industrial groups. Surplus plants and machinery available from United States, Germany and Japan should also be imported for immediate use.

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## CHAPTER IV

## REGIONAL DISTRIBUTION AND TIME-TABLE FOR THE DEVELOPMENT OF NON-FERROUS METAL INDUSTRIES

### Regional Distribution of Non-Ferrous Metal Industries

We propose that plants for the Non-Ferrous Metal Industries should be distributed as follows :—

(1) *Plants Producing Virgin Metals.*

| Metal | Location of Existing Plants | Location of Future Plants* |
|---|---|---|
| Aluminium | Bengal, Travancore | Bihar, Orissa, Central Provinces Kashmir, Mysore, Bombay (cheap and abundant power should be the main consideration). |
| Copper | Bihar | Sikkim, Rajnutana, Eastern States Agency |
| Zinc. | ... | Rajputana, Bihar, Kashmir or Punjab. |
| Lead | Bihar | Rajputana. |
| Antimony. | Bombay. | |

(2) *Plants for semi-manufactures.*

| | | |
|---|---|---|
| Aluminium sheets and circles. | Bombay, Madras, Bengal, Punjab, | Bombay, Central Provinces, Punjab, Sind, Assam, Orissa, United Provinces. |
| Aluminium Foil. | Bengal. | Bombay. |
| Aluminium Cables. | Nil. | Bombay, Punjab, South India. |
| Aluminium Powder | Bengal. | Bombay, South India. |
| Copper and Brass sheets and circles. | Bihar, Bombay, Bengal, Central Provinces, Punjab, United Provinces, South India, Sind. | Large mills in Bombay, South India United Provinces, Punjab, Sind and Bengal. |
| Copper Cables | Bengal, Bihar. | Punjab, Bombay, South India. |
| Lead pipes and sheets. | Bengal. | Bombay. |

| Metal | Location of Existing Plants. | Location of Fututre Plants.* |
|---|---|---|
| *(3) Plants for Non-Ferrous Refining Industries.* | | |
| Electrolytic copper from scrap. | ... | Bombay |
| Electrolytic tin from scrap. | Bombay, Bengal. | Bombay, Bengal, Madras. |
| Refining of white and Yellow mêtal scrap. | Several plants exist chiefly in industrial areas. | Small towns producing reasonable quantity of scrap and consuming refined products. |

## TIME-TABLE FOR FIRST-FIVE YEAR'S DEVELOPMENT OF NON-FERROUS METAL INDUSTRIES

We outline below the first five-year plan for the development of non-ferrous metal industries as we envisage it. The first two years we feel will have to be a preparatory period during which most of the preliminary work about orienting the line of development of industry, design and location of plants, etc. will have to be taken up. Starting from the third year the concrete results of planning will manifest themselves in increased production and the variety of manufactures.

**First year.**

(1) Establishment of Department of Metals and Minerals (with Sub-sections) under the the charge of a Minister for Metal and Mineral Industries.

(2) Formation of a Metals and Minerals Board to assist the Minister for Metal and Mineral Industries.

(3) Reorganisation and expansion of the Geological Survey of India to enable it to cope up better with the task of prospecting for metallic minerals, etc., and bringing it into closer co-operation with metal and mineral industries in general.

(4) Undertaking intensive prospecting with a view to locate and estimate reserves of metallic minerals and ores. Immediate attention should be paid to known deposits of copper, zinc and lead ores.

(5) Expansion and reorganisation of the Indian School of Mines, Dhanbad, to give not only an intensive education in Mining and Geology but to make it a premier institution for Research in Mining and Geological subjects.

(6) Establishment of a Technological Institute to give up-to-date training in Metallurgical subjects along with facilities for practical training-

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* Exact location of plants for manufacture of virgin metals will depend upon factors such as availability of cheap power, raw materials, water, transport facilities, etc- Location of plants for semi-manufactures will depend chiefly upon consumption in the various provinces

(7) Establishment of National Metallurgical Laboratory to deal with researches in all aspects of making, shaping and treating of metals and alloys.

(8) Sending a planned quota of Indian students and technicians to foreign countries for training in production and fabrication of non-ferrous metals and alloys. This should be continued for a number of years.

(9) Setting up a Committee for devising Indian Standard Specifications for metals and alloys.

(10) Sending a mission to Europe and America to study the latest developments in mineral and metal industries with a view to help in the planning of India's metal and mineral industries.

(11) Estimation of production capacities of firms engaged in the production and fabrication of non-ferrous metals and alloys should be undertaken by a Statistical Bureau or by the Government Department mentioned in Item (1).

(12) Revising existing tariff policies and incidence of import duties and granting of protection and subsidies to indigenous metal and mineral industries.

(13) Ordering of most of the capital goods required for semi-manufacturing industries.

(14) Drawing up plans for increasing the production of virgin aluminium up to at least 15,000 tons per year. New reduction plants could be put in localities where both bauxite and power are available.

(15) Investigating the possibilities of putting up new plants for the production of copper, zinc and lead in districts where deposits of these metals are known to occur.

(16) Drawing up plans for manufacturing electrolytic copper out of copper and brass scrap.

(17) Organising and assisting refiners of scrap metals.

(18) Increasing the use of aluminium on Indian Railways and giving first preference to Indian made goods in all Government stores purchase.

**Second year.**

(1) Surveying the work done during the previous year and appraising the value of that work. It would be better to correct the faults and revise the policies during the initial stages of development rather than let the mistake accumulate over a long period of time. This survey should be made every year and duly reported.

(2) Prospecting of the existing copper, zinc and lead deposits undertaken during the previous year would give definite ideas about their exploitation. The most promising deposits should be further surveyed for estimation of reserves, etc. and pilot plant work should be undertaken for

determining the best methods of treating these ores. At the same time investigations should be undertaken regarding facilities for power, transport of raw materials and location of smelting plants. It might also be possible to begin designing plants for the treatment of these ores.

(3) The schemes drawn up for the expansion of aluminium industy if found suitable should be immediately put into effect and plants, etc. ordered for the same.

(4) Investigations for production of manganese, beryllium and titanium alloys should be undertaken in co-operation with the National Metallurgical Laboratory which should begin functioning by now. Research work on production and fabrication of chromium alloys and other problems connected with non-ferrous metal industries could also be undertaken by the Laboratory.

(5) Capital goods ordered during the previous year for the semi-manufacturing plants would be installed by the second year and production on modern lines started.

(6) The work of the Metal and Mineral Board would by now give definite ideas to the industries as to their future policies and programmes.

(7) The work of the Committee for devising Indian Standard Specifications would also give some results and should be continued.

(8) It will be possible if complete statistics of non-ferrous metals production, consumption, imports, etc., are kept during the first year to estimate the requirements of the second year and devise ways and means of meeting these requirements. This should be done every year to enable the industry to avoid the pitfalls of either over or under production.

**Third fourth and fifth years.**

(1) As a result of the work done during the first two years it should be possible to complete the erection of new plants and begin production at least during the third year if not earlier. The Government agencies like the Department of Metals, Geological Survey of India, the National Metallurgical Laboratory, etc., should also be able to give more help to the industry during the third year. In fact starting from the third year the concrete results of planning should become manifest.

(2) Students sent abroad for training will begin to return by this time and it will be possible to do away with the services of foreign technical personnel recruited during the initial stages of development of all the existing and new industries.

(3) During the third year it should be possible to make preliminary plans for the second five-year period and it should be possible from the experience so far gained to arrive at definite ideas about future planning.

(4) If careful attention is paid to all aspects of planning, by the end of the fifth year India should have a sizable non-ferrous industry producing

virgin copper, zinc, lead, antimony, aluminium, manganese and beryllium and titanium alloys and should also be able to produce all her requirements of semi-manufactures like sheets, wires, tubes, rods, etc.

## APPENDIX I

## DEPARTMENT OF PLANNING AND DEVELOPMENT

### General Directive to Industrial Panels

It is the function of panels to make recommendations to Government regarding the development of industries, both existing and new. These recommendations should be so framed as to enable Government to prepare a detailed phased plan for the five years following the cessation of hostilities, as the first stage of a 15 year plan of industrial development for the whole country.

2. In order to assist them to formulate recommendations, panels will be supplied, as far as possible, with factual information prepared by the panel secretaries. In the case of new industries, the information will consist of a general survey of the industry and the importance of starting it in India, the availability of raw material, the power requirements, the demands of the Indian markets and the probabilities of exports. In the case of existing industries, the information will naturally be more comprehensive; it will indicate, in addition, the location of existing units, the types of goods produced, the total production under each category and the assistance, if any, given by Government. These items are to be regarded as illustrative and not exhaustive.

Government will give each panel, as a basis, for discussion the provisional target to be aimed at in the first five-year period and, wherever possible, of the target to be reached in 15 years.

3. The recommendations of the panels should cover the following points :—

(1) The scope and extent of development, including the type of products recommended.

(2) Whether the industry should be under Government ownership either on grounds of national interests or because private capital is unlikely to take it up, and if so whether it should be wholly or partly managed by Government.

(3) In the case of industries to be developed other than under State ownership, the capital required for such development, whether the whole of it is likely to be available by public investment and, if not, the extent to which Government assistance may be required.

(4) The extent to which technical advice from abroad may be necessary.

(5) The manner and the degree of co-operation with foreign firms considered necessary and desirable, both as regards capital and management.

(6) The location of the industry.

(7) The nature of the assistance required from Government in the form of protective duties, bounties, research grant, expert advice, etc.

(8) If the industry is to be under private ownership and management, what controls, if any, should be exercised by Government.

(9) What should be the organisation of the different units of the industry, e.g., should there be an industrial association? Would a cartel be desirable?

(10) The stages by which the industry should be developed.

(11) Should the industry cater for the export market?

(12) Should the industry be developed, as in Japan, on the cottage industry basis and, if so, to what extent?

4. Although, as stated above, the panels may recommend the grant of protection, it will not be their function to consider broad questions of international trade and commercial policy.

5. Joint meetings of the panels should be held, wherever necessary, to secure co-ordination, particularly where the processes and the products of one industry are connected with those of another.

6. Some of the panels have been drawn broadly and it may be necessary to co-opt members for dealing with specific branches of the industry. Members may be co-opted by the Chairman in consultation with the Industrial Adviser.

7. Before submitting the recommendations, Panels should consult Provincial Industrial Committees, particularly in the matter of location of industry. They should also, where the circumstances of the case require it, consult Industrial Committee in the States Governments/Durbars. The recommendations should be submitted to Government through the Industrial Adviser.

No. F. 35 (1)/45
GOVERNMENT OF INDIA
**DEPARTMENT OF PLANNING & DEVELOPMENT**
**Office of the Industrial Adviser.**

*New Delhi, the 3rd April, 1945.*

From

*H. K. Kirpalani, Esq., C.I.E.,*
*Industrial Adviser,*

To

*All Members of the Industrial Panels.*
*All Secretaries of Panels.*

Sir,

I am directed to invite reference to P. & D. Deptt.'s circular letter enclosing a copy of the general directive for the information of all Members of the Panels, and to say that it is desirable that each Panel should, in addition to the recommendations covered by the general directive, estimate and report on the capital goods requirements of the industries with which it is concerned, together with such details of these requirements as may be available. The Panels are also requested to indicate how much of the estimated requirements can be obtained in India and how much should be imported from abroad. It is hoped that you will give this matter your consideration.

I have the honour to be,
Sir, etc.
(Sd.) H. K. KIRPALANI,
Industrial Adviser.

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No, F. 35 (1)/45. I.A.
GOVERNMENT OF INDIA
**DEPARTMENT OF PLANNING AND DEVELOPMENT**
**Office of the Industrial Adviser**

*New Delhi, the 12th. April* ***1945.***

From

*H. K. Kirpalani, Esq., C.I.E.,*
*Industrial Adviser to the Government of India.*

To

*All Members of Industrial Panels.*

*Subject* :—INCIDENCE OF IMPORT DUTY.

Sirs,

In continuation of this office letter No. F. 35 (1)/45/IA dated the 3rd April 1945, I am directed to say that the question of the relative incidence of import duty on finished goods and the raw materials from which they could be manufactured, has been brought to the notice of the Government of India. The case of import duty on raw materials from the U. K. for the manufacture of textile stores and machinery (thirty percent) and on the finished goods (twelve and a half percent) has been cited as an example. In this case however the Government of India had deliberately reduced the import duty on finished machinery several years ago in order to encourage the development of the Textile industry, and there was then no possibility of India being able to manufacture textile stores and machinery. Now that steps are being taken to develop the manufacture of machinery in this country it is necessary to review the relative incidence of the import duty on the finished goods in comparison with the duty on the raw materials from which they could be manufactured. It is therefore requested that the Panels may examine the case in respect of the items coming under their purview, and have their views recorded in the the respective reports.

I have, etc.,
(Sd.)
Industrial Adviser.

Copy forwarded for information to :—

(1) All Secretaries to Panels.

A list of similar cases on which P. & D. Department have informally collected information is enclosed. Will the Secretaries please make arrangements to place before each Panel for examination the items in the lists as well as other similar items concerning the Panel ?

(2) The Planning and Development Department with reference to their U. O. No. P-18 (2)/45, dated the 19th March, 1945.

(Sd.)
Industrial Adviser.

Dr. A. H. Pandya (Chairman),
D.G.M.P. DDG.,
6 Esplanade East,
Calcutta.

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No. F. 35 (1)/45-I. A.

GOVERNMENT OF INDIA

## DEPARTMENT OF PLANNING & DEVELOPMENT

### Office of the Industrial Adviser

*New Delhi, the 12th Novr., 1945.*

From

*H. K. Kirpalani Esquire, C.I.E.,*
*Industrial Adviser to the Government of India.*

To

*All Members of Industrial Panels.*

*Subject* :—GENERAL DIRECTIVE TO INDUSTRIAL PANELS.

Sir,

I am directed to invite your attention to items 7 and 7-A para. 3 of the General Directive to Industrial Panels and to enclose herewith explanatory instructions relating there to for information and guidance.

I have the honour to be,
Sir,
Your most obedient servant,
(Sd.) H. K. KIRPALANI,
Industrial Adviser.

Copy forwarded for information to :—

(1) All Secretaries to Panels.

(2) The Planning and Development Department with reference to their U. O. No. P-1 (38)/45, dated the 8th November, 1945.

By order, etc.,
(Sd.) V. S. KRISHNASWAMI,
for Industrial Adviser.

**Explanatory instructions on the General Directive to Industrial Panels (Items 7 and 7-A of para. 3).**

One of the points on which panels are expected to make recommendation is the nature of the assistance required from Government in the form of protective duties, bounties, research grants, etc. The question has been raised whether this item calls for a detailed investigation by panels on the degree of protection required and recommendations thereon. What is required from the panel is only a broad indication that protection would or would not be required by an industry and not detailed recommendations which should be left to the Tariff Board to determine. It would not, therefore, be necessary for panels to investigate the costing of individual firms or to make any other elaborate investigation of the conditions of particular firms for the purpose but to base their recommendations on the broad facts of the industries with which they are concerned.

2. The relative incidence of import duty on finished goods in comparison with the duty on the raw materials from which they can be manufactured is another point on which panels have to make recommendations. So far as this point is concerned, Government merely expects that where the panels consider that the relative incidence of import duty on finished goods and their raw material is hampering or likely to hamper the Indian industry they will recommend that the matter be examined by Government. The panels need not themselves examine and make precise recommendations on what rates of import duties might be levied.

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No. F. 35 (1)/45-I. A.

GOVERNMENT OF INDIA

**DEPARTMENT OF PLANNING & DEVELOPMENT**

**Office of the Industrial Adviser**

*" N " Block Raisina Road,*
*New Delhi, the 18th December, '45.*

From

*H. K. Kirpalani Esquire, C.I.E.,*
*Industrial Adviser to the Government of India.*

To

*All Chairmen of Industrial Panels.*

Sir,

I have the honour to invite reference to para. 7 of the " General

Directive to Industrial Panels " and to say that as soon as the deliberations of Panels have reached a stage when provisional conclusions are arrived at, it would be necessary for the Panels to consult the Provincial and principal State Governments and their Industries Committees. The necessity of holding consultation at that stage will not be deemed to have been obviated by any consultation, oral or otherwise, that the Panels might have had with the Provincial Government, etc., in the course of their deliberations.

2. It is proposed that the final consultations with the Provincial Governments, etc., should take place at a meeting of each Panel with representatives of the Provincial and State Governments and their Industries Committee at New Delhi. The Secretaries to Panels are accordingly being requested to inform me after consulting the Chairman when the Panels would be ready for the discussions. As it is desirable to reduce the number of visits of Provincial representatives to Delhi for this purpose, it is proposed to hold the meetings of as many Panels as possible at one time.

I have the honour to be,
Sir,
Your most obedient servant,
(Sd.) H. K. KIRPALANI.
Industrial Adviser to the Government of India.

Copy forwarded to the Secretaries to Panels for information and compliance.

2. The stage at which the consultation with the Provincial Governments should take place is after the conclusions of the Panels have been reached in the form of a draft report approved by the Panel.

(Sd.) H. K. KIRPALANI,
Industrial Adviser to the Government of India.

## APPENDIX II

### QUESTIONNAIRE TO INDUSTRIAL FIRMS

1. What metals or alloys of semi-finished or finished materials made of non-ferrous metals are at present manufactured by your Company ?
2. Total production per annum of each of the principal products of Company.
   (*a*) In the year 1937.
   (*b*) During the war (1939-44).
   (*c*) In any other year which the industry considers typical.
3. (*a*) Location of your factories.
   (*b*) Is the industry localised in one or more regions, and if so, are there any special reasons for this localisation.

(*c*) Are there any particular regions where the industry could be suitably localised, taking into account the availability of raw materials, proximity to markets, etc.

4. (*a*) What is the kind of power used by you.
   (*b*) Do you generate it yourself or buy it.
   (*c*) Average annual consumption of power before and during the war.
   (*d*) Are the power and fuel resources of your factories adequate for any post-war extension that may be needed.
5. Raw materials (including fuel, refractories, etc.)
   (*a*) Quantities used per annum and particular localities in India from which they are obtained.
   (*b*) Amounts obtained from indigenous sources.
   (*c*) Amounts imported (please mention country of origin and the firms you buy from).
   (*d*) Present facilities for the transportation of raw materials to your factories ; are these adequate ?
6. Please describe briefly the technology of your manufacturing processes.
7. Plant and equipment now employed :—
   (*a*) Indigenously fabricated.
   (*b*) Imported (source of supply may be indicated).
   (*c*) Additions and alterations to plant contemplated.
8. Expectation of post-war consumption, internal and external.
9. (*a*) How and where do you market your products.
   (*b*) Is there a reasonably constant demand in the market for your products.
   (*c*) The scope and extent of future developments you contemplate for your industry by way of increased production, variety of manufactured products, marketing, etc.
   (*d*) Do you intend to enter or are you already in the export market. If so, to what extent ?
10. If your post-war development extend to metals other than those you now manufacture, please give a brief outline of the raw materials required, the location of plant, technology, capital requirements and estimated production.
11. (*a*) What is the amount of capital of your company and how much more do you plan to spend on the immediate and future post-war developments.
    (*b*) What amount of foreign capital, if any, is now invested in your company.

(*c*) Are your future capital requirements likely to be met by public investment in India or do you propose to use foreign capital.

12. (*a*) Do you need any government protection. If so, indicate its nature and extent.

(*b*) Do you get any government protection or assistance at present; if so, specify the same.

(*c*) If the answer to (*b*) is in the affirmative, will you need protection after the war. If so, what kind of protection will be necessary ?

(*d*) Are you aware of any protection given by Governments in other countries to industries such as yours ? If so, please give details and reference.

13. (*a*) Please state if there is now any and if so, what, government control on the production and marketing of your products.

(*b*) Do you desire any Government control of your industry after the war ?

14. Do you use any expert technical advisers from abroad and will you continue to need them in the post-war period ?

15. In case of future development of your industry depends on technical advice, patents and plants from foreign firms how do you propose to obtain them.

16. Are the raw materials or the finished products of industries similar to yours controlled by limited or world-wide cartels or associations outside India, and if so, are you a member of such an organisation or contemplate being a member of such an organisation ?

17. Would you welcome forming an association of Indian manufacturers using similar raw material or producing similar products as your own with a view to have planned production and marketing ?

18. Any other information for the guidance of the Panel will be appreciated.

## QUESTIONNAIRE TO PROVINCIAL GOVERNMENTS AND CHIEF COMMISSIONERS

1. What non-ferrous mineral deposits are available in the Province/State ? Please indicate their geological occurrence, mining possibilities and present annual production, if any.
2. What is the estimated quantity of their mineral content ?
3. Average chemical composition of the minerals available.
4. Which of the ores are suitable for extracting metals on a commercial scale.

5. Is any non-ferrous metal extracted at present ? If the answer is in the affirmative, kindly state the nature and output as well as the locality where the smelter is situated.
6. The availability of electric power, and the rate per unit at which and the authority by which it can be supplied to any works which may be established in the Province or State to increase the output of non-ferrous metals and their production.
7. Kindly suggest the existence of any subsidiary industries requiring non-ferrous metals and their products and the possibility of establishing more such industries.
8. What facilities exist at present for fabricating the metals and their alloys into rods, tubes, sheets, wires, etc. and the approximate quantities of raw materials consumed by each industry ?
9. Present requirements of non-ferrous metals and their products by Government, public utility companies, municipalities, district boards, port-trusts, etc., and also the established annual requirements by these bodies during the first five years after the termination of the war, if the information is readily available.

## APPENDIX III

### Summary of Replies from Industrial Firms

| Serial No. | Name and address of firm | Location of Plants | Type of manufacture and annual production | Power used | Expected post-war consumption in India. | New Equipment contemplated | Protection asked for. |
|---|---|---|---|---|---|---|---|
| 1 | The Indian Copper Corporation Ltd., Ghatsila P. O., B. N. Ry. | Ghatsila | Mines Copper ore and produces 6000 to 7000 tons of copper which is converted to brass sheets and circles. | 25,000,000 KWH per annum generated by self. | Same as in pre-war. (?) | 4000 K. W. Turbo-Alternator and improvements to refinery, New Cold rolling mill. | None. (They say they get no Government assistance at present.) |
| 2 | Star Metal Refinery, United India Buildings, Sir Pherozeshaw Mehta Road, Fort, Bombay. | Vikhroli, Bombay.<br>Mines in Chitral State. | Antimony metal. 200 tons per year. | 1,20,000 units per year. Coal and coke. 1000 tons per year. | 300 tons per year. | At Chitral Mines :—<br>(1) Mine Ventilation, lighting, compressed air drilling, etc.<br>(2) Hydroelectric plant.<br>(3) Aerial rope-way.<br>(4) Floatation Plant.<br>At Refinery :<br>(1) Rotary Kiln.<br>(2) Antimony Oxide plant. | Imports of Antimony in India should be banned entirely and all antimony requirements of India should be purchased from the firm at a price fixed on cost plus a certain percentage of profit basis. |
| 3 | Aluminium Corporation of India, Ltd., Kamla Tower, Cawnpur. | Jaykaynagar, Dist. Burdwan. | Aluminium Ingots, Sheets, Circles, Utensils and Aluminium Alloy articles. Total production not given. | Steam and Electricity Quantity not stated. | 6000 to 10000 tons per year. | Contemplate extension of plant for increased production but new equipment required not stated. | Protection against foreign dumping and imposition of high tariff desired. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4 | Indian Aluminium Co., Ltd., 5, Council House Street, Calcutta. | Reduction Alwaye. Rolling, Belur. Alumina, Murrie Junction. | Aluminium Sheets, and Circles 1600 tons. | 65,000 K.W.H. per month, from C.E.S.C. | 10,000 tons of sheets and circles. | Strong alloy heat treatment and laboratory. | Tariff and present polling system and reduction of internal freight rates. |
| 5 | Aluminium Manufacturing Co., 4 Fairlie Place, Calcutta. | Dum Dum | Pressings, spinnings, sheet metal work, castings and finished aluminium articles, 500 tons in 1937. | 150,000 K.W.H. per year from C.E.S.C. | Considerable Increase. | Pressure die casting. | Cheap raw materials needed. |
| 6 | Wolver hampton Works, Ltd., Bank of Baroda Building, Apollo Street, Bombay. | Worli Road, Bombay. | Aluminium hollow-ware castings and specialises in welding of aluminium Production 300 to 500 tons per year. | Pre-war 40,000 units per year. During war 116,000 units per year. | do | Does not know yet. | Does not need any other protection exept 30% import duty levied on aluminium as at present. |
| 7 | Lallubhai Amichand, 554 Kansara Chawl, Bombay. | Tardeo, Bombay. Sion, Bombay. Rangoon (pre-war). | Aluminium, brass Copper and Nickel silver kitchen utensils after rolling sheets of same, wires, strips, etc., also produced. Value of products about Rs. 450,000 per year Tonnage not specified. | 300,000 to 400,000 units per year. Supplied by Bombay Electric Supply Co. Fuel oil used for furnaces. | ... | One tilting oil-fired furnace, one electric induction furnace. Extrusion press, die casting machine. | Duty free imports of ingot metal and other raw materials like sheets circles, etc. |
| 8 | The Indian Standard Metal Co., Ltd., Chinchpokli Cross Lane, Bombay. | Chinchpokli, Bombay. | Non-Ferrous Metal ingots and sand, certifugal and die castings. Total quantity 1,800 to 2,400 tons per year. Production mainly from scrap. | 25,000 to 300,000 units per year supplied by Bombay Electric Supply Company. | Not possible to state. | Special refining furnaces. Contemplate electrolytic refining of copper scrap and putting up brass sheet rolling mill and extrusion press. | Protection against unfair foreign competition. Imposition of heavy import duty on electrolytic Copper and duty free import of copper bearing scrap. |

| Serial No. | Name and address of firm | Location of Plants. | Type of manufacture and annual production | Power used | Expected post war consumption in India. | New equipment contemplated | Protection asked for. |
|---|---|---|---|---|---|---|---|
| 9 | Kamani Metal Refinery and Metal Industries Ltd., Kamani Chambers Ballard Estate, Bombay. | Bombay, Jaipur and Lahore. | Phosphor Bronze.<br>Phosphar Copper.<br>Aluminium bronze<br>Manganese bronze<br>Arsenical Copper<br>Antifriction Metal<br>Type Metal<br>High Tensil brass<br>Total annual production :—<br>Rods 2400 tons.<br>Sheets 1200 „<br>Tubes 100 „<br>Wires 500 „<br>Castings 5000 „ | Generated by fuel oil Kurla 500 K.W.A.<br>Lahore 400 K.W.A.<br>Jaipur 300 K.W.A. | Bearing Metal 30,000 tons.<br>Rods and tubes 10,000 tons.<br>Brass Sheets 35,000 tons.<br>Copper Sheets 6,000 tons<br>Copper Black Bars 15,000 tons<br>Aluminium sheets 7,000 tons<br>Aluminium Sections 5,000 tons. | Electric furnaces for melting alloys. Brass sheet rolling mill. Extrusion press. | (1) Stoppage of imports of semi-manufactures.<br>(2) Govt. purchase of Indian made goods.<br>(3) Removal of import duty on scrap and ingots.<br>(4) Stoppage of export of N. F. metals and scrap.<br>(5) Facilities for importing capital goods which should be duty free.<br>(6) Facilities for land for factory sites where power and transportation available. |
| 10 | Binani Metal Works, Ltd., 38, Stand Road, Calcutta. | Sibpur, Howrah.<br>Salkia, Howrah.<br>Mirzapur,<br>Madras. | Ingots and rods of yellow and white metal alloys. Copper and brass wire, copper and brass rods and copper and brass sheets. Total metal production 3000 tons (not itemized) in 1944. | 80,531 units in 1944.<br>Coke, Coal and fuel oil used. | Difficult to state. | Better type of furnaces | Needed but not specified. |
| 11 | The Indian Smelting and Refining Co., Shale Building, Bank Street, Bombay. | Sion, Bombay. | Produce practically all metals and metal alloys. (?) | 800 kilo watts per annum. Source not given. | Not possible to give. | Cannot be stated. | Import duty on semi-manufactured metal such as gun metal, bearing metal, phosphor bronze, etc. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 12 | Bengal Ingot Co., Ltd., 5, Hide Road, Kidderpore, Calcutta. | Kidderpore | All classes of yellow non-ferrous metal alloys 400 to 700 tons. | About 75,000 K. W. H. per annum from C.E.S.C. | ... | No reply. | Increase of import duty on non-ferrous metal alloys and castings. |
| 13 | Saru Smelling and Refining Cor. Sadar Bazar, Meerut. | Meerut and Calcutta. | White metals, tin solder, Brazing solder. Brass, Bronze, etc. Production capacity 4-5 tons per day. | Coke fired furnaces. | Not possible to state. | Electric furnaces and sheet rolling mill in new factory. | Ta-riff on imports and bounties to high cost producers. Preference to Indian made goods in Government purchase Departments. |
| 14 | Jayant Metal Manufacturing Co., 152, Lohar St., Bombay 2. | Byculla, Bombay. | Rivets, wires, flats, strips, sheets, rods and shapes, etc., of copper, copper alloys and aluminium. Before war about 360 tons per year of building fixtures only were made. During war between 400 to 750 tons of rods and wires. | 175 units p. m. prewar.<br>400 units p. m. during war from B. E. S. Co. Coal, Coke and fuel oil used for furnace. | ... | Under contemplation. | Prohibition of imports of similar goods into India. |
| 15 | The National Rolling Mills, Ltd., Stephen House, 4, Dalhousie Square, Calcutta. | Mulagore, near Shamnagar, B. & A. Rly. | Electrolytic Copper rods in commercial lengths.<br>7,200 tons (single shift working). | 12,000 K.W.H. per month from C.E.S.C. | Not stated. | Two variable speed D. C. Motors can also roll aluminium rods for cables. | Duty free import of electrolytic copper bars. Prohibition of import of copper rods until maximum capacity of installed mills utilised. |

| Serial No. | Name and address of firm. | Location of Plants | Type of manufacture and annual production | Power used | Expected post-war consumption in India | New equipment contemplated | Protection asked for. |
|---|---|---|---|---|---|---|---|
| 16 | National Insulated Cable Co., of India Ltd., 4, Dalhousie Square, Stephen House, Calcutta. | Mulagore, near Shamnagar, B. & A. Rly. | All sizes of bare and insulated copper wires and cables for electrical industry. Production not stated but estimates wires mill production from 1946 upward about 3000 tons per year. | Installed load 1500 K.W. | Not possible to state. | Present plant not yet completed. | Higher protective tariff on all electrical wires and cables imported. Government purchase of N. I. wires and cables. Duty free import of lead and chemicals. |
| 17 | India Rolling Mills, Ltd., 4, Dalhousie Square, Stephen House, Calcutta. | 34, Simla Road, Halsibagan, Calcutta. | Ingots, rods, flats, wires, strips, sheets bars, etc., of brass, copper, zinc aluminium, lead, manganese, bronze, phosphor bronze, etc. Type of manufacture and annual production :<br>Bars, flats and strips 1650 tons<br>sheets 1650 ,,<br>wires 350 ,,<br>ingots 1650 ,, | 300,000 units per year from C. E. S. C. Coal, Coke and fuel Oil used for furnaces. | Unable to state. | Not yet considered. | Not stated, but left to Associations and Chambers of Commerce. |
| 2 | National Copper Tube Manufacturing Co., Luxmidass St., Karachi. | Karachi. | Smelting and refining of Copper and Copper Alloys. Manufacture of Copper and brass tubes and rods. Tube 24 tons<br>Rods 6 ,, | 25 H. P. from Karachi Electric Corporation. | ... | One extrusion press.<br>One electric furnace.<br>Two draw benches. | Some kind of assistance (not specified). |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 19 | Waldies Industries, Ltd., 8, Clive Street, Calcutta, P. O. Box No. 174. | Konnagar, E.I. Rly. | Lead pipes 200 tons.<br>Chem. Lead pipes 30 „<br>Antimonial Lead pipes 10 „<br>Chemical lead 30 „ | Cannot answer. | 500 to 700 tons of lead pipes. | Nil. | Removal of 30% duty on pig lead and continuation of 30% ad valorem duty on lead pipes. |
| 20 | Venesta Limited, Post Box No. 55, Calcutta. | Kamarhati, Calcutta. | Tea Lead 1500 tons.<br>Sheet 100 „<br>Above figures prewar average. During war period tea lead 4000/5000 tons per year. Lead sheet 50 tons Now changing over to rolling aluminium foil instead of tea lead. | Average prewar 57.28 K.W. per year during war 134.72 K.W. per year from C.E.S.C. | Aluminium foil about 700 tons per year in India. 500 tons per year export to Ceylon and Dutch East Indies. | Annealing plant and modification to present mill to roll aluminium foil. | As a temporary measure :—<br>(1) Prohibition of import of aluminium foil.<br>(2) Licence for import of aluminium strip in coils to be given only to this firm.<br>Long term protection :—<br>(1) Retention of 30% duty on finished foil.<br>(2) Aluminium strip in coils free of import duty. |
| 21 | The Shapraria Iron & Steel Works, Ltd., Parel Road, Bombay. | Parel, Bombay. | Lead-Ulite 225 tons.<br>Lead-Seals 2,00,000 Nos. | Very little Kerosene fuel used. | Not specified but expected to increase. | No reply. | Government buying of their products. |

## APPENDIX

### Non-Ferrous Metal Imports in all British Indian

*(All figures*

| Years | 1923 | 1924 | 1925 | 1926 | 1927 | 1928 |
|---|---|---|---|---|---|---|
| Commodity | cwts. | cwts. | cwts. | cwts. | cwts. | cwts. |
| **ALUMINIUM :** | | | | | | |
| Ingots, etc., (unwrought) | 9909 | 3690 | 4164 | 4591 | 4467 | 1858 |
| Circles | 57491 | 77318 | 74372 | 74080 | 103862 | 110905 |
| Sheets | 3653 | 2888 | 3358 | 4093 | 6427 | 5120 |
| Other Manfrs. | 8669 | 7645 | 7677 | 7329 | 6404 | 9285 |
| Total Cwts | 79722 | 91541 | 89571 | 90093 | 121160 | 127168 |
| **BRASS :** | | | | | | |
| Unwrought | 20054 | 56845 | 28670 | 18207 | 18685 | 8292 |
| Wood screws | ... | ... | ... | ... | ... | ... |
| **WROUGHT :** | | | | | | |
| Sheathings | 311334 | 434443 | 316364 | 441096 | 395255 | 471359 |
| Sheet | ... | 7619 | 20542 | 8426 | 8710 | 5236 |
| Circles | ... | ... | ... | ... | ... | ... |
| Rods | ... | 3124 | 6165 | 7658 | 11428 | 10360 |
| Tubes | ... | 1629 | 1550 | 1611 | 1696 | 1573 |
| Wires | ... | 5050 | 10186 | 7306 | 8389 | 6978 |
| Other sorts | 87942 | 112268 | 117631 | 72589 | 46055 | 41045 |
| Total cwts. | 419330 | 620978 | 501108 | 556893 | 490218 | 544843 |
| **COPPER :** | | | | | | |
| Unwrought | 57435 | 44638 | 56305 | 72930 | 29088 | 35236 |
| Old Copper | 12431 | 3222 | 2655 | 2466 | 4365 | 13286 |
| **WROUGHT :** | | | | | | |
| Brasiers | ... | 1240 | 501 | 2 | 1789 | 327 |
| Rods | ... | 2385 | 12640 | 6153 | 11450 | 82862 |
| Sheets | 143753 | 147595 | 218991 | 260355 | 178955 | 209531 |

## IV

## Ports Years 1923 to 1939, Both Inclusive

*are in cwts.)*

| 1929/30 | 1930/31 | 1931/32 | 1932/33 | 1933/34 | 1934/35 | 1935/36 | 1936/37 | 1937/38 | 1938/39 |
|---|---|---|---|---|---|---|---|---|---|
| cwts. | cwts. | cwts. | cwts. | cwts. | cwts. | cwts. | cwts. | cwts. | cwts. |
| 980 | 851 | 141 | 164 | 125 | 96 | 143 | 108 | 61 | 51 |
| 157576 | 119058 | 33466 | 16892 | 30332 | 41171 | 51990 | 51290 | 49745 | 41816 |
| 3944 | 2001 | 1239 | 1544 | 1744 | 2416 | 2710 | 3019 | 3230 | 3159 |
| 8525 | 6445 | 4583 | 5353 | 6686 | 8734 | 8673 | 8829 | 13796 | 12827 |
| 171025 | 128335 | 39431 | 24553 | 39487 | 52467 | 63516 | 63246 | 66832 | 57853 |
| 592 | 1717 | 462 | 3127 | 271 | 1136 | 2142 | 3070 | 820 | 417 |
| ... | ... | ... | ... | ... | ... | ... | 1678 | 2496 | 2850 |
| 363386 | 308488 | 298411 | 482877 | 422366 | 562673 | 428292 | 263131 | 160585 | 249820* |
| 8372 | 5703 | 6278 | 4846 | 4280 | 5481 | 2502 | 2245 | 2760 | 2661 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 13017 | 13871 | 9174 | 14461 | 9523 | 22197 | 22355 | 16412 | 16566 | 24695 |
| 2062 | 2112 | 1598 | 2404 | 2169 | 2967 | 4303 | 4588 | 3935 | 4387 |
| 9165 | 5966 | 4310 | 9971 | 6288 | 9488 | 7776 | 6599 | 7380 | 7135 |
| 35345 | 42332 | 22378 | 53506 | 26279 | 33106 | 42098 | 31744 | 24393 | 33496 |
| 431939 | 380189 | 342611 | 571192 | 47176 | 637048 | 509468 | 329467 | 218935 | 315461 |
| 15551 | 13484 | 3745 | 5571 | 14100 | 21809 | 36013 | 16277 | 47806 | 51692 |
| 5413 | 10291 | 5663 | 3088 | 2569 | 2600 | 5020 | 1991 | 2988 | 15425 |
| 1089 | 128 | ... | ... | 3052 | 1062 | 124 | 503 | ... | 190 |
| 8746 | 6826 | 34578 | 25327 | 40637 | 71304 | 72293 | 71914 | 76623 | 42590 |
| 102465 | 157830 | 141605 | 272853 | 205299 | 371239 | 279953 | 101895 | 162126 | 36832 |

## APPENDIX

| Years | 1923 | 1924 | 1925 | 1926 | 1927 | 1928 |
|---|---|---|---|---|---|---|
| Commodity | cwts. | cwts. | cwts | cwts. | cwts. | cwts. |
| Tubes | ... | 2822 | 3512 | 5459 | 5476 | 3263 |
| Wire | 9518 | 4495 | 5447 | 7103 | 4484 | 3088 |
| Other sorts | 16356 | 8729 | 13292 | 7888 | 6333 | 8445 |
| Total cwt. | 239493 | 284246 | 313343 | 362356 | 241940 | 281438 |
| GERMAN SILVER including Nickel Silver | 7286 | 13527 | 19372 | 17533 | 15135 | 25026 |
| TIN : | | | | | | |
| Ingot, Bar, Slab | 48342 | 48474 | 55259 | 51103 | 60529 | 56316 |
| Foil | ... | ... | ... | ... | ... | ... |
| Other sorts | 5051 | 3768 | 1385 | 268 | 227 | 197 |
| Total cwts. | 53393 | 52242 | 56644 | 51371 | 60756 | 56513 |
| ZINC (Spelter) : | | | | | | |
| Unwrought | 59778 | 43216 | 36323 | 37549 | 82970 | 137651 |
| Manufactured | 43345 | 64159 | 95805 | 131359 | 81839 | 49862 |
| Other sorts | ... | ... | ... | ... | ... | ... |
| Total cwts. | 108123 | 107375 | 132128 | 168908 | 164809 | 187513 |
| LEAD : | | | | | | |
| Pig | 7806 | 4895 | 2414 | 3051 | 3737 | 2458 |
| Other sorts | 325 | 134 | 782 | 1937 | 1852 | 150 |
| Wrgt. Sheet | 10623 | 10668 | 9669 | 13290 | 16515 | 13830 |
| ,, Pipes | 9325 | 4541 | 6331 | 6682 | 8811 | 7728 |
| Tea chest Sheet | 20734 | 23944 | 25958 | 17496 | 10017 | 9976 |
| Other sorts | 8005 | 7050 | 5926 | 6063 | 8127 | 10142 |
| Total cwts. | 57018 | 51232 | 51080 | 48519 | 49059 | 44294 |

IV—(*contd.*)

| 1929/30 | 1930/31 | 1931/32 | 1932/33 | 1933/34 | 1934/35 | 1935/36 | 1936/37 | 1937/38 | 1938/39 |
|---|---|---|---|---|---|---|---|---|---|
| cwts. | cwts. | cwts. | cwts. | cwts. | cwts. | cwts. | cwss. | cwts. | cwts. |
| 3426 | 4119 | 3347 | 2486 | 3594 | 3842 | 4762 | 3800 | 4328 | 4168 |
| 3150 | 4585 | 5139 | 6941 | 4233 | 7839 | 8080 | 9001 | 11519 | 9737 |
| 7504 | 7 292 | 10002 | 8598 | 5722 | 12764 | 10316 | 14245 | 10675 | 8051 |
| 147344 | 204555 | 204079 | 324864 | 279206 | 495459 | 416 561 | 219626 | 316063 | 168685 |
| 19528 | 16258 | 13551 | 17512 | 17244 | 16855 | 27371 | 27309 | 24419 | 34975 |
| 57468 | 54408 | 45251 | 47616 | 48324 | 45882 | 52591 | 42706 | 58133 | 53991 |
| 102 | 134 | 27 | 589 | 47 | 62 | 51 | 22 | 14 | 8 |
| 77 | 256 | 163 | 150 | 327 | 608 | 455 | 146 | 1998 | 2047 |
| 57647 | 54798 | 45441 | 48355 | 48698 | 46552 | 53097 | 42874 | 60145 | 56046 |
| 142682 | 169798 | 179978 | 298678 | 283882 | 344769 | 454214 | 445498 | 426580 | 504784 |
| 48634 | 37551 | 25840 | 26906 | 33510 | 30793 | 32025 | 30311 | 20005 | 15699 |
| 2526 | 185 | 170 | 398 | 300 | 298 | 478 | 302 | 72 | 2184 |
| 193842 | 207534 | 205988 | 325982 | 317692 | 375860 | 486715 | 476111 | 446657 | 522667 |
| 3726 | 3801 | 4107 | 3781 | 2595 | 2009 | 2121 | 817 | 124218 | 119017 |
| 371 | 336 | 472 | 786 | 1532 | 2094 | 868 | 1959 | 3665 | 3163 |
| 14513 | 11366 | 12450 | 8200 | 9699 | 11374 | 10069 | 9722 | 9556 | 11828 |
| 9908 | 9339 | 6606 | 6802 | 7528 | 8548 | 10205 | 10275 | 14163 | 10727 |
| 8733 | 5153 | 2820 | 861 | 820 | 538 | 190 | 412 | 36 | ... |
| 6606 | 6565 | 3748 | 6136 | 6139 | 3881 | 4098 | 2730 | 4380 | 4730 |
| 43857 | 36560 | 30203 | 26566 | 28313 | 28444 | 27551 | 25918 | 156018 | 149465 |

*Inclusive of Sheets Circles.

†Excluding Telephone and Telegraph wire.

## APPENDIX V

### NOTES ON THE POSSIBILITIES OF A LIGHT METAL INDUSTRY IN INDIA.

Alloys of Aluminium and Magnesium are commonly referred to as light alloys. They find a wide field of application owing to the advantage of lightness, strength and resistance to corrosion that they offer. These characteristics enable them to be successfully employed in a surprisingly wide range of industries ; in all branches of Engineering ; Air, land and marine Transport ; packing, chemical and food industries. Permanence and good appearance of Aluminium alloys are added features and coupled with the advantage of weight-strength ratio, they are best suited for portable or semiportable buildings, semi-structural fittings in buildings and for any machinery where movement is an essential factor. The long-range prospect is that Aluminium will eventually be the largest tonnage non-ferrous metal. An estimated world Aluminium consumption over the past 10-year period is given as under :*

| | *Percentage.* |
|---|---|
| Aircaraft, automobile, railway, marine industries | 30 |
| Food industry, cooking utensils | 15 |
| Large and small machinery | 15 |
| Electric industry: conductors, busbars, motors | 10 |
| Chemical industry | 3 |
| Deoxidising steel and heavy alloys | 7 |
| Powder, foil, seals | 4 |
| Non-recoverable scrap | 3 |
| Miscellaneous | 13 |

The largest use of light alloys is in the manufacture of aircraft, where about 75% of the aircraft is made up of these materials, the aircraft industry is consuming at present more than 90% of the entire output and will continue to be the largest consumer, though the demand for aircraft might considerably fall off in peace time. There is no aircraft industry at present in India, but with the rapid industrialisation of the country and the necessity for quick, internal and trans-continental transport, and Indian aircraft industry will become a paramount necessity. Air Force is the accepted power of defence and for the future protection of the country, the establishment of an independent aircraft industry for strategic reasons at least is necessary.

The reduction in weight of road transport vehicles will mean a direct reduction in the cost of running and an increase in carrying capacity. Apart from castings in the power units, Aluminuim alloys are extensively used for body work, roofs, seat frames, hand rails, etc. The possibilities of using Aluminium in country carts and other indigenous modes of transport deserve closer investigation.

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* Metallurgia April 1942.

The use of Aluminium alloys as a material of construction in Automobiles is well established and with advances in the technique of manufacture and increased facilities for fabrication, Aluminium alloys will seriously compete with ferrous materials. Two Companies to manufacture motor cars have already been floated in this country and, given a reasonable safeguard, an Aluminium alloy industry should be a considerable help and assistance to the success of the venture. Bicycles have been designed and built almost entirely from Aluminium alloys, and the light weight, corrosion resistance and even colour anodised cycles at a reasonable price will open new demands never thought of before. The two bicycles factories in India are producing about 200 bicycles a day and they have a potential capacity of 75,000/ 120,000 cycles a year. With a population of 400 million in India and a higher standard of living, a well organised bicycle industry should prosper and could look forward to being abreast of latest improvements by employing light metal alloys.

Complete train and coaches have been built in Europe and America from Aluminium Alloys. The increased demand for comfort which is adding to the weight of trains and for higher speeds has meant an increased demand for Aluminium Alloys. The increased wear and tear on trackes can be reduced by increased use of light alloys in place of other metals. An immediate demand from Indian Railways would conceivably be for the use of light metals for windows, sliding doors, partitions, seat frames and internal fittings.

Aluminium alloys have made important though restricted advances in the marine industry. The superstructure and deck houses built of light alloy metals will not only reduce weight but also reduce stress concentrations due to lower elastic modulus. Internal fittings, and other essential parts like life boats, parts of power unit, structural parts, will call for larger tonnages of the metal.

The light weight, high strength, corrosion resistant alloys are particularly suitable for many types of bridges, vertical lifts, aerial rope-ways and long span cranes. In the building trade, new types of roof glazings bars windows, doors, shop fronts, and decorative work etc., will contribute substantially to the Post-war demand for these light alloy metals. Aluminium alloys are admirably suited for roof structures, partitions, school and hosipital furniture etc., where cleanliness and ease of movement are essential. Other materials for the building trade are water pipes sinks, baths, boilers and sanitary equipment and for the construction of all these aluminium alloys stand unrivalled. Aluminium readily lends itself to prefabrication of houses and internal trim, and with its freedom from rust, and ability to take beautiful finishes in a wide range of colours, it is an almost ideal material in the hands of the building designer.

In India, cooking utensils and domestic appliances make up the bulk of the demand for pure aluminium. But perambulators, ladders, hand trucks and other miscellaneous articles will present a big field for the high strength alloys. In the post-war period, utility and luxury articles offer a wide scope. The chemical, food, milk and brewing and agricultural industries in other countries are already using Aluminium exclusively and the demand from these directions will expand in India also.

In Electrical Engineering, Aluminium cables will be a serious rival to copper in bare wire transmission. Germany is said to have replaced Copper in many an accepted field by Aluminium and the full details of the advance will only be known after the close of the war. India is deficient in her supplies of copper and with the unique position that copper has in the electrical industry, India can only look to Aluminium as an effective substitute.

The progress made in the finishing of light alloys will help considerably to increase the demand. The outstanding improvements made in this direction are in respect of the technique of colours anodising, by which the most beautiful range of colours can be dyed into the metal.

A post-war estimate* of the use of aluminium by Industry in America has been made as under :—

| | *Total post-war estimate.* |
|---|---|
| Transportion (land, air water) | 34 |
| Cooking utensils | 10 |
| Electrical conductor | 8 |
| Machinery and Electrical Appliances | 12 |
| Building Construction | 9 |
| Chemical | 5 |
| Foundry and Metal Working | 9 |
| Ferrous and Non-ferrous Metallurgy | 4 |
| Food and Bevarage | 55 |
| General Miscellaneous | 4 |

Many of the uses mentioned for aluminium alloys hold equally good for Magnesium alloys. The latter have the added advantage of lighter weight and are particularly useful for aircraft components. Magnesium alloys are, however, not as corrosion resistant as Aluminium alloys.

The main reason why Aluminium and Magnesium alloys will usurp the time honoured spheres of other materials and find new uses, is because of the highly developed technique of fabrication. The material can be rolled into very thin foils, extruded into intricate shapes, forged, heat treated pressed, die cast and can be revetted, welded, brazed, soldered and even joined by " plastic bonds ".

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*Engg and Minning Journal—Feb. 1944.

From the enumeration given above of the possible fields of application for light alloys it will be seen that the success of a light metal industry will depend entirely on the strength and stage of development of the fabricating industries. Realising the importance of the fabricating industries for the disposal of the metals. The Aluminium Company of America, who control more than 50% of America's total Aluminium production capacity have established a fabricating industry on a very large scale, thereby putting the metal on the market at as cheap a price as possible. India has neither a well developed basis metal producing industry nor a fabricating industry. A right beginning could be made by planning and building both the source of the basic materials and its distribution and utilisation in manufacturing industries.

A large increase in the use of Aluminium and Magnesium can be expected on account of their potential abundance, low cost and wide-spread familiarity with their properties. Although the alloys of both the metals will share in the demand, the outlook for Aluminium is clearer than that for Magnesium.

The world output of Aluminium was something like 680,000 tons in 1939 and now it is said to exceed 3 million tons. In the case of Magnesium, the production capacity which was about 30,000 tons in 1939 has now been expanded a hundred fold.

Australia has also established a flourishing Aluminium and Magnesium industry, but its production capacities are not available.

The development and prosperity of a light metal industry will depend upon the availability of raw material and the market. Though the present world position is artificially maintained for war requirements, with the return of peace radical adjustments will become imperative. The U. K. has built up an extensive fabricating industry but her position as a primary metal producer is no where comparable to it. Despite abundant coal supplies, the cost of power is high and with the almost lack of good bauxite, she has to come to some arrangements with other countries for the supply of raw materials or ingots, lest she might face a precarious future. Even before the war 70% of her ingots were imported from Canada and the need for increased imports will become more now.

The U. S. A. have the biggest aluminium productive capacity in the world, on account of the availability of cheap power, the existence of fully developed fabricating industries and of tolerably good reserve of Bauxite ores. But with the greatly increased production of the metal during the war, her raw material resources have been seriously depleted and she is feverishly examining all possibilities from the upgrading of low grade ores to the utilisation of clays. How far these developments, though technologically sound, would face the future competitive markets is not known.

Canada has plenty of cheap power and with bauxite obtained from South America she has developed a vast aluminium industry.

The reserves of Bauxite in India estimated to be over 250 million tons are largely in Bihar, the Central Provinces, Bombay and to a small extent in Madras. The better grade of Bauxite averages 55% Aluminium, 28% combined water, 8% Titanium 6% Ferric Oxide, and 3% Silica. In the purification of the red mud (Bauxite), Titanium is obtained as a bye-product, which could from the raw material for a Titanium industry.

The two essential products for Aluminium production are Cryolite and carbon Electrodes. Most of the countries are now producing synthetic cryolite (double flouride of sodium and aluminium) from Fluorspar and the same thing could be done in this country. The establishment of a carbon electrodes industry should be possible. Considerable research work has been carried out in U. S. A. in the use of low grade coals for electrode manufacture to replace petroleum coke and the utilization of (high ash) Indian coals should be investigated.

There are at present two Aluminium manufacturing concerns in India. The combined production capacity of the companies is approx. 200 tons a month, which is capable of being increased to about 650 tons a month. The Indian Aluminium Company Limited have their reduction plant at Alway, (Travancore State), in South India where they reduce imported alumina. However they are putting up a plant in Bihar to make alumina out of Indian Baxuite. The Aluminium Corporation of India which have their factory near Asansol (Bengal) have commenced production very recently.

**Magnesium.**

Magnesium is widely distributed in nature, in combination with other elements and forms 2% of the earth's crust. Magnesite is the important ore of Magnesium, though Dolomite and other Magnesium bearing minerals are employed. The bulk of the Magnesium produced in America and England comes from the Magnesium Chloride contained in the sea water. As sea water is an inexhaustible source no country can therefore claim a monopoly in regard to the supply of raw materials.

India possesses large deposits of almost pure magnesite and the reserves in South India are estimated to be over 82.5 million tons. The recent processes developed for the production of Magnesium such as the Pidgeon Process, employ Dolomite as the raw material and there are abundant deposits of dolomite distributed in various parts of the country. The sea water (Brine) is a perinnial source of Magnesium salts and there is already a plant on the west coast extracting Magnesium Salts from sea water.

The one item of vital importance in the economics of the light metal industries is the cost of electric power. Indian coal is of a relatively poor quality and the reserves are none too rich, but there is plenty of scope for the development of cheap hydroelectric power and it is estimated that the potential capacity of the country is about 27 million KWHS. There appears to be no reason why electric power should not be produced as economically as anywhere else in the world as it can be generated near the sources of the raw material.

*Aluminium Alloys :* Pure Aluminium has restricted fields of application and its use is confined mostly to chemical and food industries and to the manufacture of domestic utensils. The Aluminium Alloys are, however, of considerable importance as an engineering material and the bulk of the metal is used in the alloyed condition.

Aluminium alloys with a number of metals such as Magnesium, Manganese, Silicon, Copper, Titanium, Chromium, Iron, Nickel, Antimony, Zinc, etc. has given rise to a large number and complicated systems of alloys. The entire field and possibilities of Aluminium Alloys have not yet been explored but the properties of a few types mostly employed for war purposes, have been well understood :-

Aluminium alloys may be grouped into three main classes :—

(1) Wrought Alloys—medium strength.
(2) Wrought Alloys—strong
(3) Casting Alloys—

1. *Medium Strength Alloys :*

The use of medium strength alloys cover a wide field in which the anti-corrosion and cold forming properties are chiefly required. Though several of the alloys can be heat treated, the advantage of being cold formed without recourse to heat treatment and the ability to stand up to vibration stresses and resist corrosion are the designer's objectives.

These alloys are used extensively in the form of sheets, strips, tubes etc. Their stensil trength can be varied from 12 to 20 tons per sq. inch, depending on whether the material is required in the soft, half hard or hard state. Birma-bright alloy containing Magnesium and Manganese (4·5% Magnesium and 0·2% Manganese) is well known for its corrosion resistant properties.

2. *High Strength Alloys :*

The high strength alloys cover a wide range of compositions, and specifications. Duralumin is the best known alloy of this category and is the staple constructional material of aircraft. It has roughly the same strength as mild steel at a third of the weight. One composition develops and ultimate strength of 30 tons per sq. inch after heat treatment. It may be of interest to note that the theory of precipitation or solution hardening of aluminium alloys is still a mystery to Metallurgists and no clear concepts exist. The development of a large number of alloys and refinement in performance are due to the practical results obtained by the application of the heat treatment process rather than to any theoretical reasoning.

Aluminium is not difficult to machine with properly designed cutting tools. A special alloy (B.S. 1080) having freecutting properties has been specially designed for use in automatics.

*Casting Alloys.* The most extensive application of aluminium alloys are in the form of castings. Many types of alloys for permanent mould and pressure die castings have been standardised. These alloys can be heat-treated and have high mechanical and physical properties.

## MAGNESIUM ALLOYS

A wide range of Magnesium base alloys have been developed for many applications which make them distinctive among metals. They are the lightest structural alloys yet known, being two thirds the weight of Aluminium and a fourth that of steel. They possess excellent machinability, toughness and fatigue endurance and have a high strength weight ratio.

Though a very large number of Mangnesium alloys have been patented only a dozen alloys find commercial uses, and the alloys in current use are mostly of the Mangnesium, Aluminium, Zinc system.

Magnesium as a structural alloy is comparatively new and has not been put to the same searching investigations as Aluminium. Most of the recent developments are however not known. Magnesium alloys can be wrought, cast, forged, die cast, and extruded and an Aluminium-Zinc-Magnesium alloys lends itself for heat-treatment.

As most of the alloying elements occur in this country an investigation into the physical properties and uses of the several alloys should be made.

# APPENDIX VI

## SECONDARY METALS

### Collection Segregation and Metallurgy

The emblem of the Wasting Candle sketched by Thomas Carlyle about a century ago gives an excellent guide to a discussion of secondary metals problem of to-day. " Terar Dum Prosim " Carlyle wrote under the Candle " May I be wasted so that I be of use ".

Secondary metal may be defined as metal recovered from commercial scrap, that is scrap that has entered the processor's plant in scrap form. Metal recovered by a manufacturer from scrap arising out of his manufacturing processes in his own plant which he can readily reconvert into finished product should not be considered as secondary metal. In contrast to virgin or primary metals, i.e., metals extracted from ores, secondary metals are of secondary origin and result from the use of primary metals and alloys.

Secondary metals are most frequently referred to as scrap metals and according to their source can be divided into two important groups. First, the industrial scrap, resulting from the manufacture of wrought and cast metals and alloys and second, scrap arising from fabricated metal products which have outlived their usefulness. The secondary metal industry also performs two distinct functions ; first, reworking of the secondary metal in order to bring it to its virgin or pure state so that it can perform all the functions to which primary metal derived from ores is put ; and second, manufacturing standard alloys for which primary metals are generally used. In general then the secondary metal industry comprises of remelters, smelters, refiners and manufacturers that convert scrap metals and residues to produce refined metals, ingot alloys, fabricated shapes and chemical products.

### Problems of Collecting and Grading Scrap Metals.

Even in countries where well planned large-scale manufacturing processes are carried on, the collection and grading of scrap is a big headache. Metals and alloys which visually look alike or are even identified by the same general name may contain large or small amount of other elements and it is absolutely necessary to keep the different kinds of scrap separated to make it easy for the scrap processors to know what they are buying or how they are going to process it. In India where large-scale manufacturing is conspicuous by its absence it is all the more necessary that the different plants give some extra thought to collection and segregation of scrap arising in their plants. However all the care taken to segregate scrap metals will be wasted if the so called ' junk ' merchants who buy scrap from different sources, mix it up before selling it to processors. For this reason it is absolutely essential for the secondary metal industry to from an association of scrap dealers who can be initiated in the art and science of segregating and grading scrap. Technical advice can be given to this association by customers who buy the scrap for processing and the Chamber of Commerce or the Provincial Directors of Industries must advise the scrap producer to sell their scrap only to members of such a recognised association.

The first problem then is that of the producer of scrap. On how well he can reclaim and segregate his scrap depends the whole future of the secondary metal industry. Indian management has been lacking a great deal in the general cleanliness of their plants. Cleanliness is the first condition in the proper segregation of scrap. The dust and contamination from oil, etc. needs extra processing of the scrap and to that extent lowers the price it can fetch in the market. Each industry, each factory and each locality faces a different set of conditions. However, irrespective of the size of the plant certain fundamental principles can be applied for organisation and collection of scrap.

In the interest of clean scrap there should be appointed a foreman who along with his other duties understands the handling of scrap and should be given enough responsibility to devise his own ways and means of collecting scrap. Enough floor space should be provided in the factory for storing and proper accounting of all the scrap should be aimed at. Also the scrap should be segregated daily and a quick market should be found for the scrap so as to avoid storing large quantities. The management should take an active interest in seeing that the scrap is kept segregated.

Though metallurgical processes are available for separating alloys into their constituent metals, there are economic limitations to the use of such processes. For instance it will be more economical to melt a selected quality of brass, refine the molten metal to some standard specification and cast it into ingots for further fabrication rather than melt any collection of brass to try to recover, copper, zinc, etc., separately. This economy can only be realised if the scrap metal is separated into classes which resemble the original alloy composition as nearly as possible. For example lead is difficult to remove from leaded brass hence leaded alloys should be kept separate from zinc or tin alloys. Similarly antimony is difficult to separate from copper-base alloys and aluminium, silicon and manganese cannot be separated from copper base alloys containing high percentages of zinc without losing a large amount of zinc. Hence it is necessary to segregate these different kinds of alloys in order to facilitate recovery of the metals and also to fetch a higher price for the scrap. Segregation should as far as possible be done right at the source of the scrap producing unit. Separate containers with large markings should be provided in the machine shops, etc., and the workers should be instructed to put their scrap only in particular containers.

**Rapid Scrap identification Tests.**

In spite of the care taken to segregate different kinds of scrap mixups are likely to occur. When this occurs a rapid identification test becomes indespensable. The accompanying table* summarises some of the so called spot tests which are explained below :—

(1) Nitric acid test ; Place 1 or 2 drops of concentrated nitric acid on clean metal surface. Observe any reaction for 1 to 2 minutes. Then dilute with 3-4 drops of water and observe the reaction. If solution turns green or red use it for the iron nail test.

(2) Iron nail test : Rub a clean iron nail in the coloured acid solution in contact with the specimen. If the alloy contains copper, copper will be deposited on the nail or the metal surface.

(3) Ammonia test : Dissolve a bit of the metal in nitric acid, or attack the surface with a few drops of the acid. Dilute somewhat and add ammonium hydroxide to the solution until the latter is strongly alkaline. If copper or nickel is present a pale blue precipitate will be formed which on further ammonia addition becomes a dark blue solution.

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*Metals and Alloys August 1942, p. 365

| Material | Nitric acid test | Iron Nail Test | Ammonia Test | Paper Test | Silver Nitrate Test |
|---|---|---|---|---|---|
| Nickel | Reacts slowly, pale green solution | Negative | Blue | Intense red colour. | |
| Monel Metal | Reacts, greenish blue solution | Copper plates out | Dark blue | Intense red colour | |
| Nickel Silver | React bluish green solution | Copper plates out | Dark blue | Red colour varies in intensity with nickel content | |
| Brass | Reacts vigorously, green solution | Copper plates out | Dark blue | | |
| Tin Bronze | Reacts vigorously, blue-green solution | Copper plates out | Dark blue | | |
| Aluminium Bronze | Reacts vigorously | Copper plates out | White precipitate blue solution | | |
| Copper | Reacts vigorously blue-green solution | Copper plates out | Dark blue | | |
| Aluminium | Soluble | | White precipitate | | |
| Magnesium Alloy | Soluble | | Colourless | | |
| Lead | Soluble | | Colourless | | |
| Lead Silver solder | Soluble | | Colourless | | No precipitate in absence of tin. |
| Lead-tin solder | Soluble | | Colourless | | Black deposit with white precipitate. |

(4) Paper test for nickel : Put one drop of a mixture of 10ml $H^2SO^4$, 10ml $HNO^3$, 10ml $H^3PO^4$, 10gm. nitric acid and 25ml water on the metal for 15—30 seconds. Then absorb the drop on a paper test strip. (The test strip is made out of filter paper dipped in a solution of 10gm. citric acid, 25 ml. water 10ml of 1% dimethyl glyoxime in isopropanol and dried). When potassium hydroxide is dropped on this paper a red colour will form if nickel is present. There is no colour interference from iron or other elements.

(5) Silver Nitrate test : Treat the clean metal surface with a few drops of 2·1/2% silver nitrate solution. If tin is present a black deposit with white precipitate will form.

These spot tests are to be applied along with other tests which identify the broad classes of metals and alloys by colour, density, etc.

## Reprocessing Secondary Metal and Alloys for Recovery of Metals in the Virgin State.

As observed before one of the functions of the secondary metal industry is to reprocess the scrap in order to recover the metals in their original virgin state. This is a costly processing and is carried out only when the scrap is contaminated to such an extent that it cannot be employed directly to make standard alloys. In other words when the ratio of the elements present in the scrap or the nature and amount of elements present is such that for all practical purposes the scrap or drossings, skimmings, etc., serve only as raw materials (like ores or concentrates) for recovery of the metals. Hence reprocessing is necessary :

(1) when the metal is oxidised or entrapped in drosses, slags, skimmings, etc.

(2) when the impurities present cannot be removed easily, and

(3) when the ratio of the metals present does not allow the manufacture of standard alloys directly from the scrap.

There is not much difference between the reduction operations employed for the reprocessing of secondary metals and those employed in the conventional methods using ores or concentrates. Cupolas, blast furnaces or reverberatory furnaces are generally employed for these operations and fluxes and reducing agents are used for elimination of impurities. The refining of these metals is also carried out in the conventional ways.

## Manufacture of Standard Alloys From Scrap Metals.

The manufacture of standard alloys from scrap is the most important function of the secondary metal industry. In almost all cases it is necessary to add additional amounts of metals to the scrap composition in order to bring it to a standard specification. However, it is not necessary to use virgin metals to bring about this readjustment since the same results can be obtained by adding proportionate amounts of other grades of secondary metals and alloys. The service of a good chemist at this stage is indispensable. A paper, dealing with chemical control in a shop making brass from all-swarf melts, by Pollak and Lallowe has appeared in the "Metal Industry" of April 6 and Apiil 13, 1945. This paper deals with preliminary preparation and rapid methods of analysis of different elements for quick adjustment of brass melt compositions and must prove useful to brass remelters.

The types of secondary metals that can be used directly for alloying may consist of such industrial scrap as borings, turnings, clippings, punchings, etc., or scrap like wire, sheet, rods, pipes, utensils, castings, etc. This scrap must be graded according to its different ultimate use and must be stored when different grades are mixed together. Very often scrap has to be cleaned. Iron and steal pieces can be removed by an electro-magnet placed under a moving belt over which the scrap is spread. Oil can be removed from borings, turnings, etc., by using an inclined revolving furnace with a gas flame. The oil burns off leaving clean scrap. This can then be directly charged in a melting furnace. In many cases it becomes necessary to shape the scrap for furnace use by shearing, baling, etc.

For chemical analysis of the scrap, a proper sampling method must be used to make the sample representative of the whole lot. Different grades of scrap can be melted separately and analysed, after which different weights of the several grades can be calculated out to make a standard composition. The types of furnaces used can either be electric, gas or oil fired and even coke furnaces can be used. Much of the success of the operation depends upon the furnace temperature and atmosphere. In certain cases fluxes will have to be used not only to get rid of non-metallic impurities but to remove certain undesirable metals which might contaminate the alloy composition.

It must be borne in mind that not only the chemical analysis but also the physical properties of the alloy composition aimed should con form to a standard specification. After removal of the minute impurities through fluxing and refining the metal must be sound and uniform in structure. The final success of the operation depends on the melting practice and control of operations by a trained supervisory staff backed by a progressive management. Many instances are available of the management having no melting shop·experience interfering with the work of experienced shop superintendents. This works to the detriment of the industry and should be avoided.

So far general points regarding the treatment of secondary metals have been dealt with. The following paragraphs will deal with some important metallurgical aspects.

*Secondary Brass and Bronze* :

In this group may be included high-tin low-copper alloys with very low lead, red brasses, leaded yellow brass, leaded bushings and bearing alloys, manganese bronze, silicon bronze and aluminium bronze.

In general in the manufacture of these alloys the secondary metal is first sorted, melted and cast separately. These casts are then analysed and a charge for a standard alloy is calculated out and weighed amounts of the various grades are then melted in a suitable furnace. Air is blown through the melted charge to rid the metal of detrimental impurities or reduce them to specification limits after which they are skimmed off with the aid of a flux. The bath of metal is then poled with wood, chemically tested before and after any additions are made to bring it upto specification and finally poured into ingots and castings, after which a final chemical and physical examination is made. The physical properties of the final product will depend on several factors like :

1. Pouring temperature.
2. Melting practice.
3. Pattern equipment.
4. Sand condition.
5. Gates and risers, etc. Reliable temperature measuring instrument, sand control, etc., are to be deemed absolutely essential.

The high-tin low lead alloys require no unusual foundry technique. However, in melting this kind of scrap care should be taken to use as little virgin tin and copper as possible which can be done by aiming at a specification which requires slightly lower amounts of tin.

The technique for casting red brasses and leaded bushings and bearing alloys is very much simplified and the casting can withstand considerable pressure. The leaded yellow brasses, hower, do not cast very well. The metal is not as fluid as in the case of red brasses and clean castings are difficult to obtain. Zinc fumes are also given off which are a health hazard. These alloys are now replacing high copper alloys for low-pressure and structural castings.

The manganese and aluminium bronzes have high strength and hardness combined with resistance to sea water corrosion. Special foundry practices are necessary for casting these alloys because of high shrinkage requiring large risers. Turbulance during pouring should be at minimum. Silicon bronzes also present some difficulties during casting but not as much as the other bronzes. Great care should be taken to keep the silcon bronzes separated lest they get mixed with leaded bronze alloys where silicon is a harmful impurity.

*Secondary Tin and Lead Alloys :*

The description and class of secondary tin and lead alloys available along with its approximate composition and possible disposition is given in the following table compiled by G. L. Behr*. India does not produce any tin or lead. Hence the available secondary tin and lead should be used as carefully as possible and melting losses should be kept low.

It is desirable to segregate the different kinds of secondary lead and tin alloys as much as possible in order to avoid undue difficulties during reprocessing. However, it is not always possible to be able to buy segregated scrap and for that reason it becomes necessary to refine these secondary metals, i.e., to remove the undesirable metals either by adding another metal with which the undesirable metal alloys preferentially or by means other than those involving the use of added metals.

In cases where another metal is added for refining there forms an alloy, or intermetallic compound, of the added metal with the impurity which crystallizes as a crusty layer on the surface of the melt and can be removed easily. A very good example of this method is the Parkes process of desilverizing of softened lead in which zinc is added to form a zinc-silver alloy which is removed and treated for silver recovery.

The other methods of refining depend on the chemical re-activity of the elements to be removed. Oxidation and chlorination are the common means of getting rid of the undesirable elements which have a higher affinty for oxygen and will be oxidised in preference to other elements. In this connection the following table of the heats of formation of metal oxides will be found useful. Those metals whose oxides have a higher heat of formation can be easily removed from an alloy of several melts.

| *Metal Oxides* | *Heats of formation cal. per mol for one atom of oxygen.* |
|---|---|
| CaO | 151.7 |
| MgO | 146.1 |

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*Metal Technology T. P. 1642 October, 1943.

| *Metal Oxides* | | *Heats of formation cal. per mol for one atom of oxygen.* |
|---|---|---|
| $Al_2O_3$ | ... | 126.6 |
| $Na_2O$ | ... | 99.45 |
| $ZnO$ | ... | 83.5 |
| $SnO_2$ | ... | 69.05 |
| $SnO$ | ... | 67.7 |
| $CdO$ | ... | 65.2 |
| $FeO$ | ... | 64.3 |
| $NiO$ | ... | 58.4 |
| $H_2O$ gas | ... | 57.8 |
| $Sb_2O_3$ | ... | 55.1 |
| $PbO$ | ... | 52.46 |
| $As_2O_3$ | ... | 51.36 |
| $Bi_2O_3$ | ... | 45.7 |
| $Cu_2O$ | ... | 42.5 |
| $TeO_2$ | ... | 38.8 |
| $CuO$ | ... | 35.5 |
| $PbO_2$ | ... | 32.5 |
| $Ag_2O$ | ... | 6.95 |
| $Au_2O_3$ | ... | 3.66 |

Behr* gives the following list of the principle refining operations performed on secondary lead, tin and their alloys.

| *Elements to be removed.* | | *Removal Reagent.* |
|---|---|---|
| Copper | ... | Sulphur<br>Aluminium |
| Zinc | ... | Oxidation<br>Sulphur or sal ammoniac<br>Chlorine<br>Caustic soda<br>Lead Chlorie |
| Arsenic | ... | Oxidation<br>Zinc<br>Aluminium |
| Tin | ... | Oxidation<br>Caustic soda plus an oxidising agent<br>Chlorine<br>Lead Chloride |
| Antimony | ... | Oxidation<br>Aluminium<br>Sodium |
| Lead | ... | Chlorine |
| Iron | ... | Sulphur<br>Aluminium |

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*Loc cited.

| *General Class of Secondary Metal.* | *Approximate Composition.* | *Possible Disposition.* |
|---|---|---|
| Jewelry Metal | Over 90% Sn+Pb+Sb+Cu. | Tin base babbit by lead removal or solder by Sb and Cu removal. |
| High-grade Babbit | Over 70% Sn+Pb+Sb+Cu. | Same as above. |
| Solder | Sn and Pb+anything | Solder. |
| Electrotype metal | 3.5 Sn, 3.5% Sb, balance Pb. | Antimonial lead by tin removal. |
| **Type Metal** | | |
| Tinny hard lead | 3 Sn to 6%, 8 to 15% Sb, balance Pb. | Type metals or lead base babbit Antimonial lead by tin removal. |
| Lead base babbit | | |
| High-tin Antimonial lead | 12 to 20% Sn, 10% Sb, balance Pb. | Type metals or solder. |
| Cable lead | 2 to 3% Sn. | Common lead uses. |
| Scrap lead, sheet and pipe, Drosses of the above | Very dirty common lead | |
| Battery Plates | 4% Antimonial lead | Antimonial lead or conversion to soft lead. |

The sodium or aluminium remaining in the melt after refining is complete, can be removed by oxidation, steam, sulphur or sal ammoniac. Poling or steaming is also used for cleaning up the melt.

The choice of the removal reagent needs some thought. Costly reagents should be avoided as far as possible. For instance in decopperising with sulphur one pound of sulphur will remove about three pounds of copper and in doing so produce about thirty pounds of dross depending upon the composition of metal. Sulphur is not very efficient or economical while aluminium is highly reactive and can be used for the removal of iron, arsenic, copper and antimony from lead tin alloys. Since iron, arsenic and copper are objectionable elements and antimony needs to be reduced in most reconversion practice, aluminium is a better refining reagent for solder alloys. Each pound of aluminium will remove about three to four pounds of the above elements. If higher amounts of tin are present in the alloy the action of aluminium is more efficient than when the percentage of tin is low. After adding the aluminium the melt is stirred and its temperature raised till all the aluminium is melted. The melt is then cooled slowly when a crust forms on the surface which contains all the impurities and is removed.

Zinc when present can be removed by selective oxidation after raising the melt to a cherry-red heat. Chlorine can be used to remove zinc but it takes a special apparatus and a long time. Caustic soda though an excellent zinc remover should not be used when tin is present unless the tin is also to be removed. Lead chloride can be used to remove zinc, aluminium, sodium or any other metal higher in the chlorine series of heats of formation than lead.

Arsenic is easily removed from lead-tin alloys. Powdered zinc can be used which also removes copper. Aluminium is not a very selective arsenic remover in the presence of tin and antimony. It should be avoided for arsenic removal as far as possible because of the danger of producing toxic arsenic gas in the presence of nascent hydrogen by wet aluminium-arsenic compound.

It is not generally necessary to remove tin from lead-tin alloys. However tinny hard lead containing 8-15% antimony can be converted to antimonial lead by tin removal. Molten caustic soda with steam as an oxidising agent is perhaps the best way to remove tin. The processes of tin removal by chlorine and lead chloride are patented in America.

Antimony is best removed by oxidation. However, when tin is present aluminium should be used in order to conserve tin. Use of metallic sodium for antimony removal is quite novel in that the melt is solidified after addition of sodium and the crust formed on top is dissolved by molten caustic soda which is then ladled off.

Sometimes in contaminated tin-base metal it is necessary to remove lead. This is done by passing chlorine gas. Iron as mentioned above is best removed by aluminium.

*Secondary Aluminium* :

Immediately after the war there will be large quantities of secondary aluminium available. The proper utilisation of this material is of great importance in Indian economy because of the high prices of virgin aluminium now prevailing. Aluminium unlike copper or lead is very easily oxidised and for that reason it is not possible to refine it by ordinary metallurgical processes. There is, however, the famous Hoops process in which impure aluminium is re-electrolysed to produce 99.99% pure aluminium. This process being very costly and requiring elaborate apparatus is out of the question. The best possible way in which secondary aluminium can be utilised is for the manufacture of standard alloys if the scrap is properly segregated or for degrading virgin aluminium. Fluxing of the melt by chlorine gas is recommended.

Aluminium alloys can roughly be classified into common or non-heat-treatable and heat-treatable alloys. These are again divided into cast alloys and wrought alloys. Very broadly it can be said that alloys containing copper magnesium and nickel are strong or heat-treatable alloys while those containing manganese, iron or silicon are non-heat-treatable.

In order to promote the increased use of a secondary aluminium it is neessary to know what the scrap consists of. If it is segregated scrap of standard alloy and has not been contaminated the best way to use it would be by mixing it with primary metal for the production of an alloy of the same composition. The controlling factor in deciding whether scrap or remelted ingots can be used for this purpose is the composition. In case of wrought product the elements to be considered are iron, silicon, zinc, tin and lead which are mostly there as impurities while in casting alloys magnesium also needs consideration along with the other impurities.

The problems that arise out of not segregating the aluminium scrap are so many that it becomes difficult to find a use for such metal. In cases where contamination is not serious small amounts of this metal may be added in similar alloy metals. Of course the problems of utilising such scrap arise only when standard alloys are attempted. In India where almost any kind of aluminium is used by the small utensil manufacture with complete disregard as to the corrosion resistance, etc., of the final product, and where moderate drawability, spinnability or castability is the only criterion for selection of the metal, utilisation of this kind of scrap have presented few headaches. In order to identify different aluminium alloys the following spot tests may be used :—

*Chemicals required.*

20% caustic soda solution
30% nitric acid
50% ammonia solution
1% alcoholic solution of dimethylgloyxime.

(*i*) *20% Caustic Soda*—A drop of 20% caustic soda solution is applied to a cleaned surface of the metal and allowed to react for 3 to 5 minutes. The surplus liquid is then removed with blotting paper and the colour of the resulting stain is observed.

WHITE stain indicates, pure aluminium or magnesium alloy.

GREY-BROWN Loose stains indicates a high silicon-aluminium alloy.

BLACK adherent stain indicates either Duralumin or Hiduminimum R. R. type alloy.

(*ii*) *30% Nitric Acid*—One drop of 30% nitric acid is then added to any coloured stain produced by the caustic soda solution. If complete solution of the stain does not take place a high silicon content is indicated.

(*iii*) *50% Ammonia Solution*—Two drops of a 50% ammonia solution are added to the drop of acid whatever may have been the action of the latter on the original stain.

BLUE colour formation indicates the presence of copper in alloying quantities.

(*iv*) *1% Alcoholic Solution of Dimethyl Glyoxime*—Finally one drop of a 1% alcoholic solution of dimethyl glyoxime is added.

Brilliant RED colour spreading over the spot in 1 minute shows the presence of appreciable quantities of nickel.

Faint RED edge to the spot merely indicates a trace of nickel as an impurity.

*Secondary Magnesium* :

All the remarks amout segregating secondary aluminium also apply to secondary magnesium. The variety of magnesium alloys are very few and the majority of both cast and wrought magnesium alloys contain aluminium, magnesium and zinc. Magnesium requires great care in handling and under no circumstances wet scrap should be stored, shipped or recovered because of the danger of hydrogen evolution leading to spontaneous combustion. Magnesium base alloys are easily identified by a silver nitrate spot test. The silver nitrate turns jet black on magnesium and remains colourlesss on aluminium. Magnesium scrap is not generally baled because of the lower magnesium recovery on baled magnesium. Copper, silicon, iron and nickel are harmful impurities in magnesium and care should be taken not to contaminate the scrap with these materials.

The melting and casting of magnesium require special precautions. Melting is generally done in cast iron pots and gas or oil is used as fuel. Fluxes with magnesium chloride base with other halide salts are added both for refining and protective action. After melting is completed the metal is raised to a temperature of 800 to 900°C before casting. Unlike aluminium the higher temperature refines the magnesium grains. Sulphur is used as a protective flux while pouring magnesium alloys. In cases where a magnesium fire breaks out care should be taken not to use water or any other extinguishers except those specially recommended to extinguish magnesium fires. These recommended extinguishers should be kept handy and the workmen instructed in their use.

In conclusion it must be said that in India a secondary metal industry is as important as starting new non-ferrous metal industries. India is lacking in workable ore deposits of most of the non-ferrous metals, and before the war most of her requirement of non-ferrous metals were met by imports. The present war has brought home the need of a sizable metal industry in India. Every pound of lead, tin copper or other metals salvaged will add to the self sufficiency of the country. However all such salvages must be done under expert metallurgical advice to avoid waste.

# APPENDIX VII

## Schedule No. 1

*Summary of major plant required to produce brass and non-electrolytic copper strip foil and circle*

| Total Plant required including brief details of specifications. | Plant already in existence in India.* | Units of Plant to be ordered. | Has Plant to be imported or can it be produced in India. | Approx. price per unit of imported plant. (In £) | Total price of imported plant. (In £) |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Thirteen—1400 lb. capacity low frequency induction furnaces complete with all ancillary equipment including electrical gear, plate-forms and fume plant. | 4 | 9 | To be imported | 2,555 | 23,000 |
| Nine spare sets of lining for above ... | ... | 9 | do | 50 | 450 |
| 100 water cooled good quality close grained cast iron ingot moulds. | 20 | 80 | Can be made in India. | ... | ... |
| Six 10 ton capacity copper reverbatory furnaces complete with all ancillary equipment. | 1 | 5 | do | ... | ... |
| Four 24"×36" motor driven reversing hot rolling mills with live and idle roller tables. | 1 | 3 | To be imported. | 20,000 | 60,000 |
| Four sets of electrical equipment for the above mills. | 1 | 3 | do | 3,500 | 10,500 |
| 17 pairs spare rolls 24"×36" for the above mills. | 4 | 13 pairs. | do | ... | 6,500 |

*Does not include equipment existing in Indian Ordnance Factories.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Four motor driven guillotine shearing machines for cutting hot rolled plate to length. | 1 | 3 | To be imported. | 1,000 | 3,000 |
| Pour sets of electrical equipment for the above sheers. | 1 | 3 | do | 100 | 300 |
| Three roll flatteners ... | 1 | 2 | do | 1,500 | 3,000 |
| Six No. slab milling machines with 20″ face cutters. | 2 | 4 | do | 2,050 | 8,200 |
| 36 spare cutters for the above millers 6″ diam.×20″ face. | 12 | 24 | do | ... | 2,880 |
| Three pneumatically operated turnover tables. | 1 | 2 | do | 375 | 750 |
| Fifteen lengths of idle roller conveyor table ... | 5 | 10 | do | ... | 3,000 |
| Three motor driven swarf elevators ... | 1 | 2 | do | 800 | 1,600 |
| Three 25 HP motors with control gear for nine roll flattener | 1 | 2 | do | 150 | 300 |
| Six 70 HP motors with control gear for slab milling machines. | 2 | 4 | do | 270 | 1,080 |
| Three 2 HP geared motors with control gear for swarf elevators. | 1 | 2 | do | 90 | 180 |
| Nine 30″×5 ft. motor driven two high non-reversing hot rolling mills, complete with motor operated passover table. | 2 | 7 | do | 15,600 | 109,200 |
| Nine sets of electrical equipment for the above mills. | 2 | 7 | do | 800 | 5,600 |

| | | | | | |
|---|---|---|---|---|---|
| 37 pairs spare rolls 30"×5 ft. for the above mills. | 10 pairs probably in existence at Ghatsila. | 27 pairs | To be imported. | ... | 39,150 |
| Three continuous electric resistance furnaces for pre-heating the blooms. | 1 coal fired. | 2 | do | 16,000 | 32,000 |
| Nine electric resistence furnaces for intermediate heating and final annealing. | 3 coal fired. | 6 | do | 3,500 | 21,000 |
| Nine sets of electric equipment for roll adjusting gear of 30"×5 ft. mills, comprising 15 HP 720 RPM in hour rated motor complete with break and contractor type control gear. | 2 | 7 | do | 3,500 | 24,500 |
| One 18"×30" motor driven two high reversing cold rolling mill with coiler. | 1 But will be required solely for lead and aluminium. | 1 | do | 11,500 | 11,500 |
| One 200 HP 720 RPM reversing motor with control gear for the above mill. | 1 But will be required solely for lead and aluminium. | 1 | do | 1,200 | 1,200 |
| One 2½ HP 930 RPM motor with control gear for above mill. | 1 But will be required solely for lead and aluminium. | 1 | do | 200 | 200 |
| Three pairs hardened steel rolls 18"×30" for the above mill. | do | 3 pairs | do | ... | 2,400 |
| One 14"×24" motor driven two high non-reversing strip mill with coiler. | do | 1 | do | 7,500 | 7,500 |
| One 150 HP 720 RPM motor with control gear for the above mill. | do | 1 | do | 850 | 850 |
| Three pairs spare hardened steel rolls 14"×24" for the above mill. | do | 3 pairs | do | ... | 2,100 |
| One 12"×20" motor driven two high non-reversing strip mill with coiler. | do | 1 | do | 5,500 | 5,500 |

| 1 | 2 | 3( | 4 | 5 | 6 |
|---|---|---|---|---|---|
| One electric resistance bell type furnace for intermediate and finish annealing of strip. | 1 | Nil. | ... | ... | ... |
| One 120 HP 720 RPM motor with control gear for the 12″×20″ mill. | Not to spare. | 1 | To be imported. | 800 | 800 |
| Three pairs spare hardened steel rolls 12″×20″. | Not to spare. | 3 pairs. | do | ... | 1,050 |
| Six 5 ft. guillotine shears, complete with electrical gear. | 2 | 4 | do | 200 | 800 |
| One 6″×12″ motor driven gang slitting machine complete with scrap cutter, coiler, etc. | No modern machine exists. | 1 | do | 1,300 | 1,300 |
| Electric equipment for above slitter and scrap cutter. | ... | 1 | do | 80 | 80 |
| Spare cutters and distance pieces of slitting plant. | ... | ... | do | ... | 150 |
| Ten motor driven circle cutting shears complete with electrical equipment. | 3 | 7 | do | 500 | 3,500 |
| Two heavy duty roll grinding lathes. ... | Several exist in India. | Nil. | ... | ... | ... |
| One precision roll grinding lathe ... | One in existence. | Nil. | ... | ... | ... |
|  |  |  |  |  | 369,670 |

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†Writer's estimated price all other prices are plant manufacturers' estimates.

## Schedule No. 2

*Summary of major plant required to produce brass and non-electrolytic copper wire in coil.*

| Total plant required including brief details of specifications. | Plant already in existence in India. | Units of plant to be orderded. | Has Plant to be imported or can it be produced in India. | Approx. price per unit of imported plant. (In £) | Total price of Imported plant. (In £) |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| One multiple wire drawing machine complete with all electrical gear. | Not in existence apart from cable companies. | 1 | To be imported. | 3,720 including electrics. | 3,720* |
| Four multiple wire drawing machines complete with all electrical gear. | do | 4 | do | 1,240 do | 4,960* |
| One multiple wire drawing machine, complete with all electrical gear. | do | 1 | do | 1,982 do | 1,982* |
| One pointing machine complete with electrical gear. | No modern machine apart from cable companies. | 1 | do | 326 do | 326* |
| One "pulling in" machine ... | Not in existence, apart from cable companies. | 1 | do | 164 do | 164* |
| One multiple wire drawing machine complete with all electrical gear, 4 die non-slip. | do | 1 | do | 2,544 do | 2,544* |
| Four multiple wire drawing machines (nine dies) complete with all electrical gear. | do | 4 | do | 1,166 do | 4,664* |

Does not include equipment existing in Indian Ordnance Factories.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| One No. 4 pointer ... | No modern machine apart from cable companies. | 1 | To be imported. | 155 including electrics. | 155* |
| One hand pointer ... | do | ... | do | 37 do | 37* |
| Eleven butt Welders ... | In existence, but not to spare. | 11 | Can be imported or made in India. | 100 | 1,100 |
| Two bell type electric resistance furnaces, each with four hearths atmosphere generating plant operating with anhydrous ammonia included, together with a hoist for handling the equipment. | Nil. | 2 | To be imported. | 5,500 | 1,000* |
| | | | | | £30,652 |

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Plant Manufacturers' approx. price.

† Writers' estimated price,

## Schedule No. 3

*Summary of major plant reduced to produce brass and non-electrolytic copper rods and tubes*

| Total Plant required including brief details of specifications. | Plant already in† existence in India. | Units of Plant to be ordered. | Has plant to be imported or can it be produced in India. | Approx. price per unit of imported plant. (In £) | Total price of imported plant. (In £) |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Four 4 cwt. low frequency induction furnaces complete with all ancillary equipment including electrical gear, platforms and fume plant. | Nil. | 4 | To be imported. | 1,278 inc. electrics | 5,112 |
| Four spare sets of lining for above ... | Nil. | 4 | To be imported. | 25 | 100 |
| Four ten ton capacity copper reverberatory furnaces, complete with all ancillary equipment, including fuel pulverizer. | Does not apply, as must be erected on site. | 4 | Can be made in India. | ... | ... |
| One complete set of good quality close grained cast iron ingot moulds. | May be in existence. | 1 set | do | ... | ... |
| Three Billet cutting saws ... | do | 3 | do | ... | ... |
| One electric resistance furnace for pre-heating the billets. | Nil. | 1 | To be imported. | 3,500 inc. electrics. | 3,500* |
| One horizontal hydraulic press 1700 tons capacity. | Two second hand presses, of unknown capacity, are in order. | May, or may not be necessary to order 1. | do | 51,800 inc. electrics. | 51,800* |

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*Does not include equipment existing in Indian Ordnance Factories.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Three single chain drawnbenches for working loads up to 10 tons. To be fitted with 3 speed gearing to give chain speeds of 40, 60 and 80 ft. per min. and arranged for drive with 35 H. P. Motors. | No modern machine. | 3 | To be imported. | 1,200 inc. electrics. | 3,600* |
| Two single chain drawbenches for working loads up to 30 tons. To be fitted with 3 speed gearing to give chain speeds of 20, 30 and 40 ft. per min. and arranged to drive with 60 H. P. Motors. | do | 2 | do | 1,950 inc. electrics. | 3,900** |
| One standard batch type electric resistence furnace, complete with charging machine and charging tables 22′ 9″×3′ 9″ wide×1′ 6″ high. | Nil. | 1 | do | 7,000 | 7,000** |
| Bar and tube straightening machines including inlet and outlet troughs and all electrical gear. | | | | | |
| One Type 0 A<br>One Type 1 A<br>One Type 1½B<br>One Type 2 B<br>One Type 2½B | No modern machines | 5 | ... | 485<br>1,333<br>1,273<br>2,800<br>3,500 | 9,191** |
| | | | | | 84,203* |

**Piant Manufacturers' Approx. Price.

†Writer's estimated price.

## Schedule No. 4

### *Aluminium Sheet, Strip and Circles*

| Total Plant required including brief details of specifications. | Plant already in existence in India. | Units of Plant to be ordered. | Has Plant to be imported or can it be produced in India. | The Approx. price per unit of imported plant. (In £) | Total price of imported plant. (In £) |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| Three 10 ton capacity coke fired special reverberatory furnaces complete with all ancillary equipment. | 1 | 2 | Can be made in India. | ... | ... |
| 60 water cooled close-grained good quality cast iron ingot moulds. | 20 | 40 | do | ... | ... |
| Three continuous chain conveyor electric pre-heating furnaces with special discharge arrangement. | 1 | 2 | To be imported. | 9,000 | 18,000 |
| Three 24″×30″ motor driven two-high reversing breaking down mills complete with live roller tables, and guillotine sheers for cutting strip to length. | 1 | 2 | do | 26,000 | 52,000 |
| Three sets of electrical equipment for the above mills. | 1 | 2 | do | 4,250 | 8,500 |
| 15 Pairs spare chilled cast iron rolls 24″×30″ for the above Mill. | 6 pairs. | 9 pairs. | do | ... | 4,150 |
| Three electric annealing furnaces 12′ 6″ long×5′ wide×2 ft. high. | 1 at Belur. | 2 | do | 6,500 | 13,020 |

| 1 | 2 | 3 | 4 | 5 | 9 |
|---|---|---|---|---|---|
| Six 9 ft. Guillotine shears ... | 3 | 3 | To be imported. | 300 | 900 |
| Nine 30″×4′ 6″ motor driven two-high cold rolling mills. | 7 | 2 | do | 15,000 | 30,000 |
| Nine sets of electrical equipment for the the above Mills. | 7 | 2 | do | 500 | 1,000 |
| 22 Pairs spare rolls 30″×4′ 6″ for the above Mills. | 10 Pairs probably at Belur and Asansol. | 12 pairs | do | ... | 16,800 |
| Two heavy duty roll grinding Lathes ... | Several in existence. | Nil. | ... | ... | ... |
| 20 Motor driven circle cutting machines, complete with electrical equipment. | 4 | 16 | do | 500 | 8,000 |
|  |  |  |  |  | 152,350 |

## Cost of Plant and Equipment for Refinery and Copper Electrolysis Plant (Capacity 10,000 tons of electrolytic copper per year).

| | | Rs. |
|---|---|---|
| (1) | Cost of land and Civil Engineering ... | 15,00,000 |
| (2) | Building and erecting charges ... | 30,00,000 |
| *(3) | Furnaces, filter plants, costs of Copper Electrolysis Plant including Electrical Equipment ... | 80,00,000 |
| **(4) | Cost of plant to treat by-product ... | 14,60,000 |
| *(5) | Transport equipment, travelling cranes, etc. ... | 5,80,000 |
| **(6) | Power Station or Transformer station ... | 9,50,000 |
| *(7) | Laboratory Equipment ... | 50,000 |
| (8) | Furniture and Fixtures for office, workman's canteen, etc. ... | 1,20,000 |
| **(9) | Tools for maintenance workshop ... | 1,20,000 |
| (10) | Contingencies, 15% on items 1 to 9 ... | 23,67,000 |
| (11) | Finance required for metal stocks, if based on pre-war rates for trading and working capital ... | 35,00,000 |
| | Total ... | 2,16,47,000 |

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*Items 3, 5 and 7 are capital goods which would have to be imported.

**About 20% of items 4, 6 and 9 may be obtained locally or are labour expenses incurred for erection.